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SPECIAL ARTICLE

A FURTHER CONTRIBUTION TO OUR KNOWLEDGE OF INSECTICIDES.

Fumigants.

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In a paper* read before the International Congress of Zoölogists at Boston in 1907, certain facts were presented relative to the comparative germicidal, insecticidal and toxic values of a number of substances which are well known for one or another of these properties. (See Table of Coefficients, page 228.) The various methods of testing were noted but particular attention was given to the method of insecticidal valuation of those substances which are applied by contact in liquid form or in solution.

The present paper contains the results of experiments with substances used as fumigants or by contact in vapor form and is in a sense a continuation of the previous work.

The fumigation method of applying insecticides is one which appeals to any one who has had occasion to combat insects in houses or premises

*A Contribution to Our Knowledge of Insecticides. Chas. T. McClintock, E. M. Houghton, H. C. Hamilton.

where the vapors or gases can be confined a sufficient length of time to become effective. Such methods are now in common use for the treatment of stored grain for weevil, of nursery stock and the more valuable orchard trees for scale and white flies, and for driving out or destroying flies and mosquitoes.

The heat treatment for stored grain and flour now being successfully used is a convenient modification of the fumigation process.

TABLE OF COEFFICIENTS.

	Toxicity.	Germicidal	Insecticidal
Arsenic	40.	.7	50.
Alcohol	.09	.025	.05
Carbolic Acid Aq. Sol	1.	1.	1.
Carbolic Acid Soap	.5	.75	2.
Coal Tar Disinfectant	.27	5.	4.
Coal Tar Insecticide	.2	.5	125.
Cresylic Acid and Soap	.4	2.	2.5
Morphine Sulphate	1.33	.5	2. —
Nicotine	53.	1.	15. + —
Potassium Cyanide	83.	.5—	5.
Mercuric Chloride C. P.	20.	300.	5— +
Mercuric Iodide (discs.)	20.	1000.	5+
Linseed Oil Soap	.16	.5—	5.
Formaldehyde		16.	4.
Sulphuric Acid		5.	15. + —
Turpentine Soap		1.	40.

The table herewith quoted is from our paper mentioned on the previous page. It is a summary of the work, a reprint of which will be supplied on application to Parke, Davis & Co., Detroit, Mich.

There is as yet no extensive use of the fumigation method for insect eradication. The reason for this may be partly due to lack of exact information as to substances applicable and how to use them. So far there has been no comprehensive classification of the substances which may be used in combating insects, nor of the various methods which make each of value.

A convenient classification is one based on the way they can be used to best advantage. By such a system the substances group themselves into four classes as follows:

I. Those used by contact in liquid form or in solution.
II. Those used by contact in dry or powdered form.
III. Those used by contact in vapor form.
IV. Those used by mixing with food or the ingestion group.

The value of this form of classification is in no way impaired by the fact that some substances will be included in more than one of the classes. Every substance which can be made use of by a certain method of application should appear in that class. Insect powder, or specifically the powdered half-opened blossoms of Chrysanthemii cinerariifolium, may be used as such, may be used by burning, or may be extracted by some sol-

vent and made use of in solution. It should therefore appear in each of these classes.

The third class, or those which are applied in gaseous or vapor form, includes such substances as occur in that form or from which a gas or vapor may be generated. This may be produced by evaporation at room temperature for very volatile substances, or at an elevated temperature for those less volatile, or may be generated by bringing about a chemical reaction.

Although the U. S. Government has published details of methods for destroying scale and for combating household insects with Hydrocyanic Acid Gas, reference to the literature for information on the action of fumigants disclosed little of practical value. Trillat and Lagandre,* in an article entitled "Etude sur la Toxicite des Vapeurs de quelques Substances Chimiques sur les Moustiques," which appeared during the course of our work, described some experiments with several substances used as fumigants three of which, Nicotine, Pyridine, and Quinolin gave quite remarkable results. These high values were only partially confirmed by our experiments.

In this series of experiments we have attempted to test substances which have been used as insecticides for their values under certain conditions making for high efficiency, and also under such conditions as would obtain in the practical application of the process. A bell jar was used for the former, while for the latter a ventilation hood such as are common in chemical laboratories was adapted to the purpose, supplemented by room and house experiments as practical tests.

In the hood experiments recorded in Table I a sliding window and a hand hole closed by a plug provided the necessary openings for placing apparatus, materials and insects, while a slide operated from without served admirably to open and close the suction draft and thus secure ventilation. The hood was also provided with steam, gas and electric stove for generating the vapors, and these were so arranged as to control the heating without disturbing the experiment. These different methods of heating were necessary because of the varied characters of the substances used, among which were the highly inflammable and very volatile substance Carbon Disulphide, and Creosote Oil, its antithisis, which requires a temperature of 300° C. for quick and complete volatilization. The vessels in which the substances were placed for generating vapors or gases required some changing to suit the substance, but in general the rule was followed to give the greatest surface and least depth possible and heat so applied that volatilization could proceed rapidly and completely.

* Hygiene Generale et Applique'. Vol. IV. No. 9. p. 542.

The charts shown in Fig. I are reproductions of the sheets used for recording experiments. It will be noted that these four are sufficient to determine the final value of sulphur for each of the five insects used in Table I, since the quantity used in each experiment was just sufficient to kill one or more, and in most cases insufficient to kill others of the species used.

Other than these shown in the illustration no attempt is made to give details of experiments where the amount of the substance used was insufficient to kill the insects. It is needless to say that four experiments were not sufficient to determine the coefficients for each of the insects. It is necessary to determine in almost every case the length of time required for volatilization, the rate at which this should best be carried on, the length of time during which the insects should be exposed to the vapors, to say nothing of the great number of experiments necessary to determine the minimum quantity which would kill the insects in question.

Throughout this series of experiments the primary object has been to make them of the greatest practical value. Therefore the insects used were those species which may be considered as common household pests, the eradication of which is desired by everyone. The list of those used in the hood experiments includes the bed-bug, cockroach, moth, fly and mosquito.

The bell jar experiments, although not of practical value, serve to indicate the efficiencies of substances under ideal conditions. For this reason no attempt was made to determine their value except for the most resistant insect, namely the bed bug.

One of the difficulties experienced in using the bell jar was that when any substance required heating and especially if it must be burned to generate the active vapors, the escape of these vapors was inevitable. To overcome this it was decided to withdraw the air from the jar and then restore equilibrium after vaporization had been accomplished. This introduced another difficulty as combustion required oxygen. Finally the plan was followed which is best understood by a glance at the illustration. (See Fig. II.)

Through one of the stop cocks at the top of the jar in illustration II the suction pump produced a partial vacuum. Through the other the degree of pressure was recorded on the gauge which is shown to the left of the jar. Through the lower stop cock the vapors were drawn into the jar. The substance to be vaporized was placed in the flat, brass dish, heated from below by gas, steam, hot air, or any convenient method, the vapors being collected in the funnel. When vapor-

Fig. I.

INSECTICIDE EXPERIMENTS.

FUMIGANTS.

SUBSTANCE Sulphur DILUTION 300,000
QUANTITY 2.6 VAPORIZED BY burning
TIME 9.00 TO 9.04 TO 3.04 HOURS 18
DATE 10/5 -1910 OBSERVED BY H + L

No.	INSECTS	NOTES	RESULTS
4	BEDBUG	not stupefied	not killed
10	COCKROACH	not stupefied	not killed
70	HOUSE FLY	not stupefied	not killed
10	CLOTHES MOTH		dead
50	MOSQUITO	not stupefied	not killed

INSECTICIDE EXPERIMENTS.

FUMIGANTS.

SUBSTANCE Sulphur DILUTION 750,000
QUANTITY 3.9 VAPORIZED BY burning
TIME 11.00 TO 11.04 TO 11.04 HOURS 1
DATE 11/5 -1910 OBSERVED BY H + L

No.	INSECTS	NOTES	RESULTS
4	BEDBUG	not stupefied	not killed
10	COCKROACH	not stupefied	not killed
70	HOUSE FLY		dead
4	CLOTHES MOTH		dead
50	MOSQUITO		dead

INSECTICIDE EXPERIMENTS.

FUMIGANTS.

SUBSTANCE Sulphur DILUTION 700,000
QUANTITY 11g VAPORIZED BY burning
TIME 10.00 TO 10.04 TO 11.04 HOURS 1
DATE 11/5 -1910 OBSERVED BY H + L

No	INSECTS	NOTES	RESULTS
3	BEDBUG	not stupefied	not killed
70	COCKROACH		dead
70	HOUSE FLY		dead
4	CLOTHES MOTH		dead
50	MOSQUITO		dead

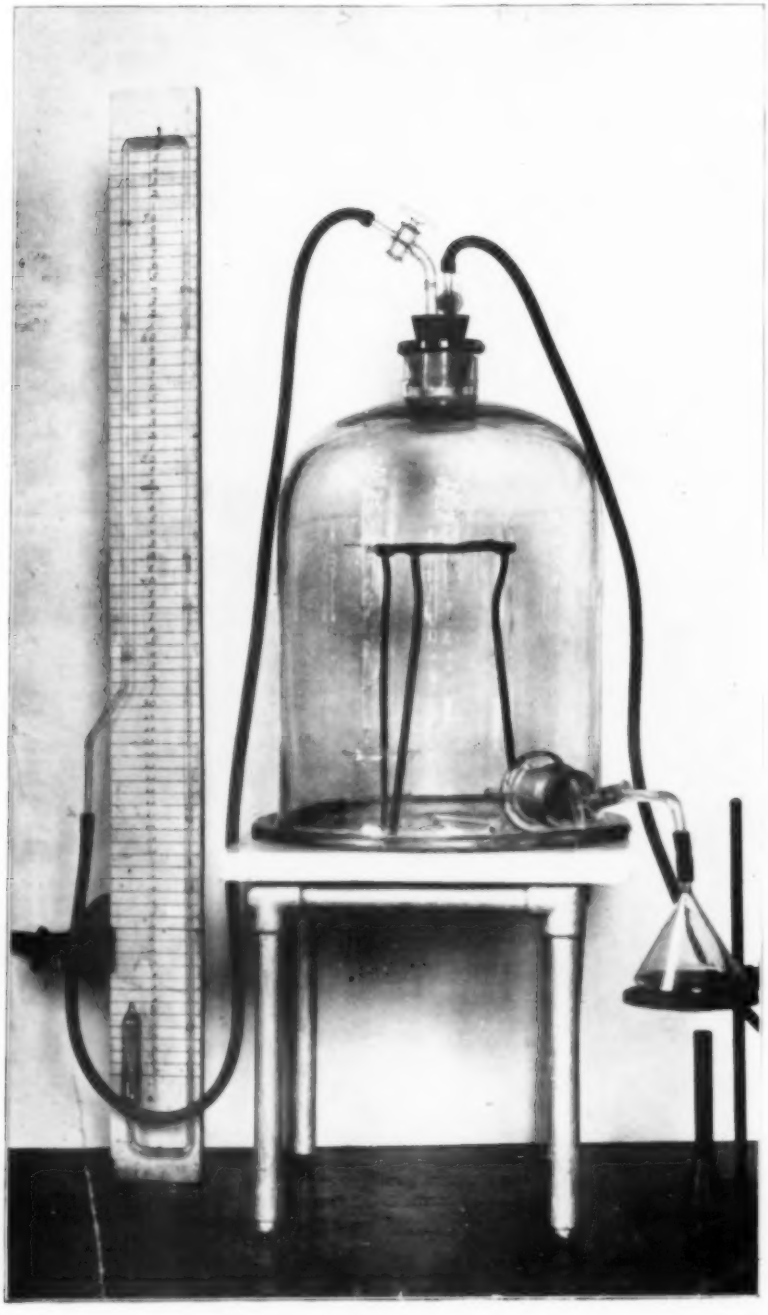
INSECTICIDE EXPERIMENTS.

FUMIGANTS.

SUBSTANCE Sulphur DILUTION 100,000
QUANTITY 8g VAPORIZED BY burning
TIME 8.00 TO 8.04 TO 9.04 HOURS 1
DATE 11/5 -1910 OBSERVED BY H + L

No	INSECTS	NOTES	RESULTS
4	BEDBUG		dead
10	COCKROACH		dead
10	HOUSE FLY		dead
3	CLOTHES MOTH		dead
60	MOSQUITO		dead

Fig. II.



ization commenced the cock was opened sufficient to create a draft, with the result that no loss of vapors occurred at any time, the preliminary exhaustion of the air from the jar causing a better contact with its base than is possible otherwise.

This method made possible the measuring of definite proportions of gases which could be drawn from a container, such as illuminating gas, sulphur dioxide, carbon dioxide and hydrogen sulphide. These gases were introduced into the jar when the gauge indicated 680 mm. mercury and when the vacuum had dropped to one half or any desired quantity, the remaining partial vacuum was made up with air. In this way the effective dilution of the gas or vapor was readily determined.

The results in Table II are those obtained by exposing the insects for one hour to the vapors of the different substances except as noted in two cases. Nicotine and Pyridine are two substanes which require a longer exposure to the vapors to bring out a high efficiency. For that reason values are given both for one hour and for three hours exposure. The former, however, more nearly coincide with the results to be expected in practice.

The "quantity" column shows both the amount which, when vaporized in the 15550 Cc. bell jar, was efficient and the next smaller amount which was insufficient to kill the insects. The coefficient column shows the relative efficiency of the substance compared to the efficiency of sulphur dioxide vaporized in the hood. This was done not only for convenience in having only one standard, but to compare the values of the substances vaporized under different conditions. One fact that should be noted regarding the method made use of in obtaining these results is that bed bugs are not killed by being kept in an exhausted container for four hours. When insects are placed in a bell jar and the air removed, they quickly become dormant as though dead, but even after four or five hours so exposed, they recover and appear as healthy as ever.

The list of substances used was made up largely from those drugs or chemicals which are considered to have value as insecticides. It is not exhaustive, but is intended merely to clear up the mass of contradictory evidence regarding these values. As in the work with contact insecticides one of these substances was selected as a standard for comparison. On account of the high esteem in which burning sulphur is held as a general fumigant, this substance was selected as a standard. Sulphur can be obtained in practically a pure state, it remains unchanged under ordinary conditions and with proper manipulations it can be completely burned to sulphur dioxide, the most active form in which this substance occurs.

The most convenient method for indicating the value of a substance is to determine that dilution of its vapors which will kill the insects in question, that is, to obtain the ratio between the efficient weight or volume of the substance and the space in which its vapors were confined. The unit of space selected was 100,000 Cc. because of its easy transposition into the commonly used measurement of cubic feet; 1 to 100,000 is the same ratio as 1 oz. to 100 cubic feet. Therefore in the scale of values the *unit is that quantity of sulphur which will kill the bed bug when burned in an enclosed space of 100,000 Cc.* and *the efficiency of any substance may be expressed by a number which is its Sulphur Dioxide Coefficient.* Thus if 8 gm. or 8 Cc. of any substance were required to kill the bed bug in the 800,000 Cc. chamber, the efficient dilution of that substance is 1 to 100,000 and its coefficient is 1.

The actual quantity necessary to destroy members of any particular species of insect must, in most instances, be worked out for that species because of the disparity in the resistance of the different species toward any fumigant. And although the Sulphur Dioxide Coefficients of many substances are found to vary in much the same way for the different species, the amount of variation cannot be known except by actual experiment.

Table I is a list of the substances tested and the species of insects used in the hood experiments, together with the quantity of each substance which, when properly transformed into vapors, was sufficient to kill the species indicated. The coefficient column shows the inverse ratio between this quantity and 8 grams, the weight of sulphur which, when burned, kills the bed bug in the 800,000 Cc. of enclosed space.

The efficient dilution of the vapors of any substance may be obtained from this coefficient by multiplying by 100,000.

For example, if one wishes to use carbon disulphide, by consulting No. 28 in the Table I it is shown that 24 grams were required to kill bed bugs where only 8 grams were required of Sulphur. It is therefore only 1-3 as strong and its coefficient is 0,3+. Its efficient dilution is 33,000.

Sulphur when quickly and completely burned is a most effective insecticide. It is objectionable as a general fumigant because of the poisonous and suffocating vapors of the sulphur dioxide gas, its chemical action on metals and coloring fabrics and the difficulty experienced in effecting its complete combustion. To be efficient it must burn rapidly and completely. Under proper conditions it burns readily, is not quickly dissipated and has a prompt effect on the insects. This effect is not merely stupefactive as no insect once overcome ever recovers.

INSECTICIDE EXPERIMENTS.

TABLE I—Hood.

Time of exposure—Varied as conditions required.
Column 1—Quantity used to kill the specified insect.
Column 2—Coefficient of efficiency compared with the efficiency of Sulphur Dioxide on bed bugs.

Substance	Bedbug		Cockroach		Housefly		Clothes Moth		Mosquito	
	1	2	1	2	1	2	1	2	1	2
1 Sulphur Dioxide as Sulphur	8	1	4	2	3.2	2.5	2.6	3	3.2	2.5
2 Pyridine	8	1	4	2	2	4	1.6	5	1.6	5
3 Pyridine Bases (Merck)	5	1.6	4	2	1.6	5	1.6	5	.....	.....
4 Quinoline	8	1	8	1	.....	.....	2	4	.....	.....
5 Creosote Oil	4+	2	4+	2	2	4	1	8	8	10
6 Carbolic Acid	8	1	8	1	8	1	8	1	4	2
7 Napthalene	8+	1	8	1	2	4	4	2	1	8
8 Kerosene	16+	0.5	16+	0.5	4+	2	4	2	4+	2
9 Amilin Oil	6.3+	1.3	6.3+	1.3	6.3	1.3	6.3	1.3	4	2
10 Cedar Oil	11.5+	0.7	11.5	0.7	8	1	2	4	1	8
11 Citronella Oil	4+	2	4+	2	2	4	4	2	1	8
12 Cloves Oil	4+	2	4+	2	2	4	2	4	1	8
13 Peppermint Oil	4+	2	4+	2	4	2	4+	2	2	4
14 Pennyroyal Oil	8+	1	8+	1	4	2	4	2	1	8
15 Australene	8+	1	8+	1	3.2	2.5	8	1	2	4
16 Turpentine(Oregon Fir)	36+	0.2	36+	0.2	36+	0.2	16+	0.5	8	1
17 Oil Pinus Palustris	16+	0.5	16+	0.5	4	2	4	2	2	4
18 Oil Turpentine	20+	0.4	20+	0.4	20	0.4	20	0.4	10	0.8
19 Turpentine (Mich. Wood)	16+	0.5	24+	0.3	16	0.5	16	0.5	.....	.....
20 Benzaldehyde	4+	2	4+	2	2	4	2	4	1	8
21 Nitrobenzol	8+	1	8	1	1.6	5	1.6	5	1	8
22 Ammonia 28%	36+	0.2	36+	0.2	20+	0.4	36+	0.2	20	0.4
23 Alcohol, Ethyl	80+	0.1	80+	0.1	80+	0.1	80+	0.1	80	0.1
24 Alcohol, Methyl	80+	0.1	80+	0.1	80+	0.1	80+	0.1	80+	0.1
25 Acetone	40+	0.2	40+	0.2	40+	0.2	40+	0.2	14+	0.2
26 Chloroform	40+	0.2	40+	0.2	16+	0.5	16+	0.5	16+	0.5
27 Ether (Ethyl Oxide)	.....	.....	.....	.....	15+	0.5	.....	.....	.....	.....
28 Carbon Disulphide	24	0.3	36	0.2	4	2	2	4	4	20
29 Carbon Tetrachloride	40	0.2	40+	0.2	40+	0.2	40+	0.2	40	0.2
30 Chloretone	4+	2	4+	2	4	2	4	2	1	8
31 Camphor	8+	1	8	1	4	2	4	2	2	4
32*Nicotine, 80% Sol	25	4	25	4	6	20	25	40	1	100
33 Hydrocyanic Acid, as Potassium Cyanide	6.3	1.3	6.3	1.3	2	4	1	8	2	40
34 Paraform	8+	1	8+	1	4	2	8	1	1	8
35‡Formaldehyde 40% Sol.	54+	0.1	54+	0.1	16+	0.5	16+	0.5	8+	1
36 Stramonium Leaves	10	0.8	10	0.8	10+	0.8	10+	0.8	4	2
37 Sabadilla Seeds	8+	.....	8+	.....	16	0.5	16+	0.5	4	2
38 Chrysanthemum Flowers	80+	0.1	80+	0.1	2.6	3	4	2	1	8

The + sign after a number indicates that this quantity was the largest used and that it was insufficient.

* Coefficient of Nicotine based on 100% Alkaloid.

‡ Quantity of Formaldehyde to be an efficient germicide is 13½ Cc. or a Coefficient of 0.625.

INSECTICIDE EXPERIMENTS.

TABLE II—Bell Jar. Capacity 15550 Cc.

Insect used—Bed Bug.
Time of exposure—1 hour, except as noted.

Substance	Quantity	Coefficient	Time	Result
1. Sulphur	0.052	3		dead
	0.039	4		recov.
2. Formaldehyde Sol. 40%	0.31	0.5		dead
	0.26	0.6		alive
3. Creosote Oil	0.052	3		dead
	0.039	4		alive
4. Cresylic Acid	0.052	3		dead
	0.039	4		alive
5. Carbon Disulphide	0.077	2		dead
	0.052	3		recov.
6. Chloroform	1.6	0.1		dead
	1.04	0.15		recov.
7. Carbon Tetrachloride	1.6	0.1		dead
	1.04	0.15		recov.
8. Australene	1.15	1.0		dead
	0.10	1.5		alive
9. Benzaldehyde	0.15	1.0		dead
	0.10	1.5		alive
10. Nitrobenzol	0.21	0.75		dead
	0.15	1		partial recov.
11. Chrysanthemum Flo. Fl. Ex.	2.0	0.08		alive
12. Illuminating Gas	33.33%			alive
	50.00%			dead
13. Eucalyptol	0.031	5		dead
	0.026	6		alive
14. Menthol	0.2	0.8		dead
	0.15	1		alive
15. Pyridine	0.031	5	1 hr.	dead
	0.015	10	3 hr.	
16. Nicotine	0.021	0.75	1 hr.	dead
	0.210	7.5	3 hr.	

Pyridine is much more effective when it volatilizes slowly. Spontaneous evaporation is the best method, the room to be closed for 15 hours or more; at the end of that time the odor will usually be dissipated. It is worth noting that the value of Pyridine is enormously enhanced when evaporated in a practically air tight container. In some bell jar experiments a coefficient of 30 was obtained. It should also be noted that it has value only as a fumigant since a solution for contact work is almost useless.

Pyridine bases, the mixed bases separated from Creosote Oil, is not materially better as an insecticide than pure Pyridine. It must be gently heated to generate vapors in sufficient quantity to be effective against insects, and a long exposure is necessary.

Quinolin, one of these pyridine bases easily obtained, has practically the same value as pyridine with the disadvantage of having a more repulsive odor. Like pyridine it has a remarkable high value when volatilized in an airtight chamber. This high efficiency is, however, not obtainable in practice.

Creosote Oil has as high a value as pyridine, and in some cases higher. It has the disadvantage, however, of leaving an oily deposit which becomes objectionable when used in a proportion greater than 1–200,000 and cannot therefore be used for eradicating bed bugs. The objection to the use of any substance which leaves an oily deposit is that in most cases varnish is softened, thus greatly limiting its usefulness. Its persistent odor in clothing also is an objectionable feature.

Carbolic Acid is efficient in quantities which do not leave a deposit, but is much less valuable than the Creosote Oil from which it is derived. It is exceptional in that the coefficient of efficiency is the same for four different species of insects.

Naphthalene is in no essential respect different from Creosote Oil, except that it leaves less deposit and is slightly less effective.

The value of Kerosene is limited because of its leaving an oily deposit when volatilized in any quantity, and also because of its inflammable nature.

The essential oils and turpentine oils are in general of limited value. They have an agreeable odor, but the question of cost limits their use to mixtures where the odor is an advantage.

Aniline Oil is of value for mosquitoes, but its tendency to deposit oil prevents its use in larger quantities. The same may be said of benzaldehyde and nitrobenzol, neither having sufficient efficiency against bed bugs or cockroaches.

The group comprising ammonia and the two alcohols, acetone, chloroform and ether may be stated as without efficiency. Camphor and chloretone, similar substances, were found of considerable value for mosquitoes, but for other insects of not much value.

Where it is possible to use nicotine in the form of the pure alkaloid, very good results can be obtained, the fumes being extremely efficient and not objectionable if the rooms are properly aired. No other preparations yet tested show as high efficiency as this alkaloid under ordinary conditions.

Hydrocyanic Acid was somewhat disappointing, except when used on the clothes moth and mosquito. For bed bugs, cockroaches, flies, the quantity is very considerable and taken in connection with its extreme toxicity it seems advisable not to recommend it for general fumigating purposes.

In view of the results obtained by the use of gaseous formaldehyde it seems absurd to recommend it as an insecticide, since quantities much more than efficient for germicidal action are practically without effect on any of the insects. Although some of the clothes moths were found dead in this dilution not a sufficient number were ever killed to give it any value. Paraform, polymerized formaldehyde, is much more efficient than its concentration would indicate. No reason has yet been deduced for this somewhat peculiar fact.

A remarkable thing about insect powder is that while very efficient against the house fly, moth and mosquito, it was absolutely inert when used as a fumigant against the bed bug and the cockroach. This is one substance which allows application in a variety of ways. It seems equally efficient for certain insects in powder form, in solution as an extract, and as a vapor driven off by heating.

In order to compile from the data obtained in these experiments a list having any working value, it is necessary to apply a process of elimination. For instance, however effective a substance may be, if its cost is prohibitive, its use dangerous to life, or the method of its generation impracticable, that substance is consequently excluded from consideration.

Several factors were found to affect materially the values of some substances, namely, rate of generation of, and time of exposure to the vapors, also, in some cases, the location of the test insects in regard to the generating vessel. In general it may be stated that the more rapidly the full charge of gas or vapor is produced and permeates the air space, the more efficient the substance is. However, the vapors of some of the more slowly acting substances are, if rapidly produced, completely dissipated before they have had sufficient time to become effective. So, in such a case a slower evaporation or generation is necessary to allow a longer exposure to the vapor. This appears to be particularly true, of pyridine and the other coal tar bases, since a charge rapidly volatilized in the hood failed, while the same quantity allowed to evaporate at room temperature was effective.

The further fact that these substances had such high coefficients when volatilized in the air tight bell jar points to the same conclusion. The vapors were effective when much more greatly diluted, probably because they were retained for a longer time. The time of exposure is noted in the detailed experiments and deductions drawn as to the necessity for long exposure where the time factor is important.

Insects frequently appear to be dead from the action of certain vapors after only a short exposure. If removed and placed in fresh air they will

completely recover, while if they were allowed to remain in the fumigation chamber for several hours they would not recover.

The location of the insects with regard to the generating vessel is not so important as might be supposed, since in most instances vapors and gases, regardless of their specific gravity, completely permeate the air space which is enclosed. If the space to be fumigated is not tightly closed, however, those gases lighter than air will escape upwards and those heavier than air downwards, and thus insects may be so located as to escape contact with them.

It should be noted in this connection that the result of a fumigation with any substance may not coincide with the results obtained in the experiments here recorded. Several conditions affect the results of fumigation experiments very materially. A high wind, low barometer, low temperature, loosely constructed buildings, all tend toward decreased efficiency. On the other hand the average house will retain the vapors longer than the ventilation hood used in these experiments, since it was purposely left far from air tight. In fact our room experiments have shown that the coefficients of value obtained from the hood experiments are low. In other words, less of the substance than that indicated by the coefficient will be necessary to accomplish the destruction of insects, because houses built for comfort in this climate will retain the fumes for a longer period.

For a practical use of any of the substances to which a coefficient has been assigned in these experiments, the necessary quantity may be easily computed. Thus, the capacity of the premises, expressed in cubic feet, divided by 100 times the coefficient, is the number of ounces of the substances necessary to kill that particular species for which the fumigation is intended.

$$\frac{\text{Capacity in Cubic Feet}}{100 \times \text{Coefficient}} = \text{ounces to be used in any room.}$$

In every case the liquids are measured and the solids weighed.

SUMMARY.

1. The fumigation method for eradicating household insects is practicable.

2. These different species of insects, the bed bug, cockroach, clothes-moth, fly and mosquito, vary greatly in their resistance to fumigants.

3. The value of substances used as fumigants depends on a proper choice both of the substance and of the method used in its volatilization.

4. Many of the substances recommended as fumigants are either without value, or are greatly over rated.

5. It is possible to standardize substances which are subject to sophistication or deterioration by comparing the efficient dilution of their vapors with that of a product of known purity. This is particularly applicable to solutions of Nicotine and to Powdered Chrysanthemum Flowers.

6. As yet there is nothing from which to conclude what action the vapors have on the insects. If it were merely irritative, formaldehyde would be valuable and the vapors of burning insect powder without value. If the action were similar to anaesthesia, chloroform should have been of greater value. If the action were purely that of poisoning one would have expected the highly poisonous Hydrocyanic Acid Gas to be of exceptional value for all species of insects.

Further experiments are being carried out with those insects which infest trees and plants, animals, granaries and flour mills, the results of which will be communicated in a subsequent paper.

American Public Health Association

ORGANIZATION OF THE PENNSYLVANIA STATE DEPARTMENT OF HEALTH.*

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Paper Read by B. FRANKLIN ROYER, M. D.,
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If you were to ask me to tell you the foundation upon which the entire structure of the State Department of Health of Pennsylvania is built, the pivot of the whole organization, the theme that runs through the work of every division, I should say it was GETTING CLOSE TO THE PEOPLE.

Clothed with ample power to enforce the broad comprehensive health laws enacted for our execution, we started with this assumption: "Our people want to be healthy if they only know how." It was our business therefore to teach them.

The public press of the state, nine hundred journals strong, responded splendidly to our call for aid. To every fireside in Pennsylvania they have carried the message of health and life. Civic clubs, labor organizations and the big employers of labor throughout the state were asked to work for the cause, and they have been constant and effective mediums through which we have reached the people. From every pulpit in Pennsylvania we have spoken through the pastor to his people and I cannot begin to tell you how much good has been accomplished through this channel. We believe in reaching the boys and girls who will soon be our men and women, and so our tuberculosis and general sanitary exhibit, as it travels through the state, makes a particular point of interesting and instructing the school children. The little people learn the lesson of health themselves and they help us wonderfully in reaching the grown-ups, and thus by the time our organization was well under way, we found that the people were coming to us, for instance, to disinfect their homes after tuberculosis.

Do you not see now what I mean by getting close to the people? Can there be any other result than a general uplift in the social and economic as well as the health conditions among those of our citizens who need help? We

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find that such people are beginning to look upon their government as their very good friend and helper. They are learning that the State Department of Health is something more than a mere sanitary policeman; that it's sole aim is to go hand in hand with them as a guide through the darkness of ignorance and disease, out into the sunlight of right living.

Prior to the Act of June 3, 1885, the public health work in the Commonwealth of Pennsylvania was limited to measures of quarantine at the port of Philadelphia and to spasmodic measures of quarantine in the larger municipalities. The Act of 1885 provided for the appointment of a Board of Health consisting of six persons, the majority of whom were to be physicians of good standing, and a secretary who also was to be a medical man of not less than ten years professional experience.

Dr. Benjamin Lee, a member of the profession of whom we may all be proud, a gentleman who represents the highest type of medical man, was elected secretary. By virtue of his office he became the chief sanitary officer of the Commonwealth, retaining this position continuously for a term of twenty years. The Board of Health did a great deal of good in an educational way, but was so crippled in its work by lack of funds and was so circumscribed in its powers and duties that this twenty-year period may now be looked upon as an era of splendid missionary work.

The first sanitary code of Pennsylvania, adopted June 18, 1895, required the reporting to health officers of but eleven diseases. This act had been in part enforced in the larger cities but remained almost a dead letter so far as country districts and small municipalities were concerned.

The year 1905 is a memorable one in the Commonwealth of Pennsylvania from a public health standpoint, because in this year the most comprehensive and effective legislation for the protection of the health of the public ever adopted in any state of the Union was enacted by the legislature and signed by the governor of the state. This legislation consisted of three acts, a brief resume of each being necessary to a proper discussion of the present system of organization.

First: "An Act creating a Department of Health and defining its powers and duties."

Second: "An Act to preserve the purity of the waters of the state for the protection of the public health."

Third. "An Act to provide for the immediate registration of all births and deaths throughout the Commonwealth of Pennsylvania."

All three of these acts were passed by the same legislature and approved by Governor Pennypacker during the month of April, 1905.

THE ACT CREATING THE DEPARTMENT OF HEALTH is typical of modern legislation and centralizes authority in the hands of the Commissioner.

Provision is made for an Advisory Board, consisting of five physicians and a Civil Engineer, whom the Commissioner can call upon for the purpose of consultation and the adoption of rules and regulations. A companion act carried with it a liberal appropriation and afforded ample means for putting into force all reforms believed to be necessary to place health matters in Pennsylvania on a high plane.

THE ACT PROVIDING FOR THE PREVENTION OF THE POLLUTION OF PUBLIC WATERS delegates all authority for protecting the streams and other sources of supply to the Governor, the Attorney General and the Commissioner of Health, and completes the groundwork upon which the present organization is based.

VITAL STATISTICS. The registration of births and deaths had been shamefully neglected up to this time. The third act, referred to by title, places this registration system in the Department of Health.

The Commissioner is ex-officio a member of the Quarantine Board of the port of Philadelphia, the Water Commission, the Medical Council and the Dental Council.

In addition to the general grant of authority the Commissioner is "to determine the most practical means for the suppression and prevention of disease."

To summarize briefly, the acts specifically provide that the Commissioner shall determine what assistants are necessary to carry out the work imposed upon the Department and places the appointing power in him. It also enables the Commissioner to purchase all supplies and materials necessary for carrying on the work of the Department; to issue subpoenas to secure the attendance of witnesses and compel them to testify; to issue warrants to any sheriff, constable or policeman; to apprehend and arrest such persons as disobey quarantine orders or regulations of the Department—these warrants must be executed forthwith and a return of the execution must be made to the Commissioner; to either personally or by his agents without fee or hindrance, enter, examine and survey all grounds, schools, apartments, buildings and places suspected of containing nuisances or questions affecting the security of life and health and to confer the authority of constable on his agents for such purposes; to order nuisances to be abated and removed and to enforce quarantine regulations; to have the general supervision of the state registration of births, marriages, deaths and communicable diseases; of practitioners of medicine and surgery, of midwives, nurses and undertakers. Any violation of the Department's orders issued by the Commissioner constitutes a misdemeanor and is punishable by fine or imprisonment or both.

Such are the powers conferred by these respective acts. Previous legislation provided for the organization of local Boards of Health in cities, boroughs and townships of the first-class. A few of the larger cities were already doing effective work. The smaller boroughs and towns were doing nothing except in times when smallpox became epidemic, when spasms of activity would be noted that were not always rational, only to die out with the end of the epidemic. All the vast rural and mountainous regions of the state were without Boards of Health, or systems of registration of any sort, and the only certificates of births and deaths in these communities were to be found on the church registers. Up to this time human beings were born, lived long lives and were buried with less likelihood of official record of their existence than was the case with high bred horses, cattle or dogs. Municipalities and private estates were permitted to discharge their sewage into the great streams of the Commonwealth without hindrance.

It is to the credit of the medical profession that the notable legislation upon which the present Department of Health in Pennsylvania bases its organization was planned by one of Pennsylvania's broad-minded active medical men. Dr. Charles B. Penrose drew the acts, presented arguments in their favor to the various legislative committees, and deserves the credit for their adoption.

ORGANIZATION.

The present organization of the Department of Health has been worked out under the power and authority conferred upon the Commissioner by the three acts just referred to. The first essential work was the organization of a Bureau of Vital Statistics, as provided by one of the three acts of 1905. A Division of Medical Inspection was organized almost simultaneously and these two departments were followed by the Division of Sanitary Engineering, the Division of Laboratories, the Division of Biological Products and the Division of Tuberculosis Sanatoria and Dispensaries. It very soon became evident that two additional divisions were required; one for purchasing, auditing and accounting, and another for the distribution of supplies required for the vast work. These various divisions rapidly grew to great size and usefulness, and today most of them have a number of important sub-divisions.

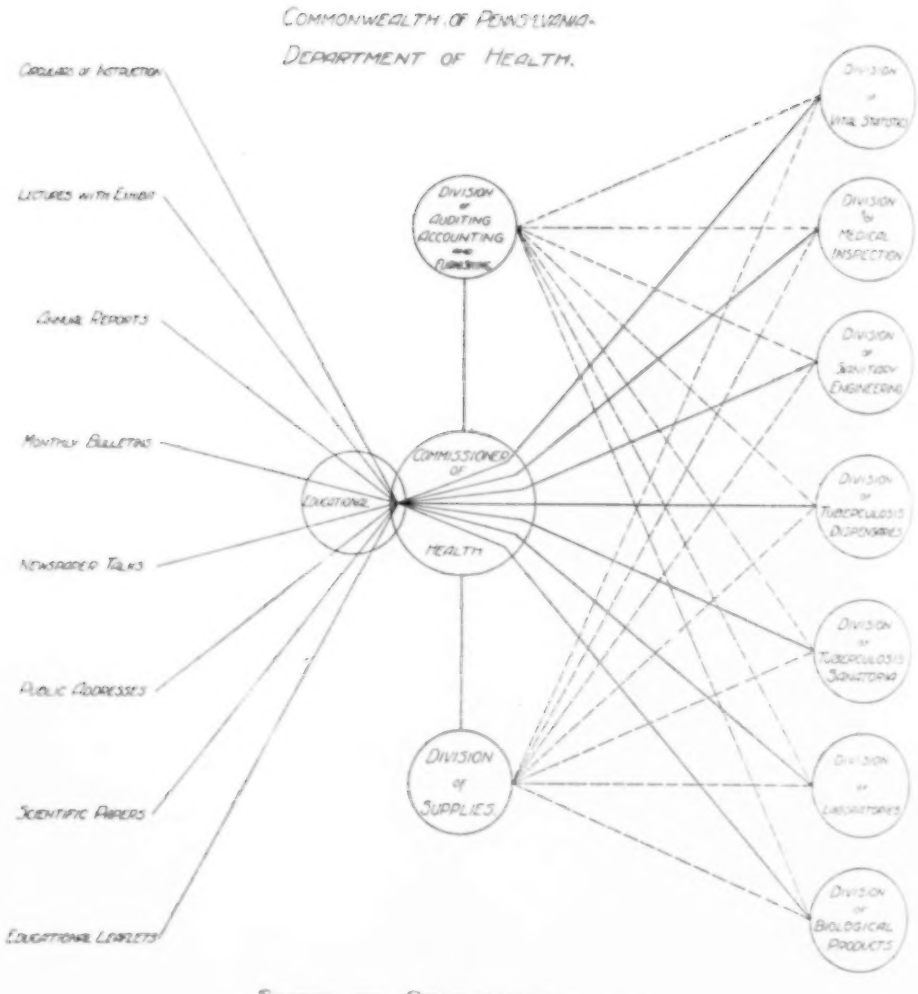
The Bureau of Vital Statistics has a registrar in charge, a full office staff and local registrars and deputies, one in each city, borough and large centre of population. These men receive all birth and death certificates in their respective communities, transmit copies of them to the Registrar of the Department and issue all burial permits previous to interment,

being compensated for their work by the respective counties. The Statistical Bureau seemed to be the natural place for developing a subdivision of Morbidity Statistics. A plan was evolved whereby upwards of 700 Health Officers should be appointed to represent the Department in the various districts in each county. Among their duties as the local representative is that of receiving morbidity reports and forwarding them to the Department of Health. Like provision has been made for the County Prothonotary to transmit to the same Bureau copies of marriage certificates filed with them by those authorized to perform the marriage ceremony. The total number of persons making reports directly to this division at the present time consist of 1170 local registrars, 670 health officers, and 67 county prothonotaries.

THE DIVISION OF MEDICAL INSPECTION as organized, consists of a Chief Medical Inspector, an Associate Chief Medical Inspector, an office staff, a Medical Inspector in each County and a number of Health Officers (the same men who report morbidity statistics). Their duties in the Medical Division consist of placarding houses on receipt of a morbidity report, establishing quarantine under the supervision of the County Medical Inspector, and disinfecting premises at the conclusion of communicable diseases.

The County Medical Inspector becomes practically the Department's consultant in his district and directs all quarantine measures through his Health Officers, is frequently called to see those sick with communicable disease, assist where necessary in establishing the diagnosis, enforces the Department's regulations for the sale of milk in premises infected with diphtheria, scarlet fever, typhoid fever, smallpox and epidemic meningitis, represents the Department in local outbreaks in communities having Boards of Health and supervises sanitary conditions of his county in general.

The Department was soon able to extend the work in the Division of Medical Inspection to a campaign of sanitary education reaching to dairy farms and to public schools. Twice each year the Health Officers visit all premises throughout the Commonwealth marketing milk and make a comprehensive report to the Department—the last inspection reaching 35,000 farms and stables producing milk. Twice each year these same Health Officers visit public schools, some 13,000 in number, and make full reports of the sanitary condition of the school room, its grounds, outbuildings and water supply. Often special inspections are made by them of insanitary conditions, nuisances, etc., in their respective districts and abatements are ordered through them, this particular part of their work being directed by the Division of Sanitary Engineering.



SCHEME OF ORGANIZATION - - -

Early in the organization the Medical Examiners for the great railways of Pennsylvania, 105 in number, were appointed deputy medical inspectors to the Department of Health to serve without salary, and were clothed with sufficient power to arrest on sight persons on railway trains or in railway stations believed to be carrying infection of communicable disease.

An additional corps of medical inspectors for public schools has been appointed and work already started.

A corps of volunteer physicians rendered valuable aid to the Department in the early days of its existence by reporting menaces to health, nuisances in various communities, and by calling attention to irregularities in work undertaken by small Boards of Health.

The force in the Medical Division at the present time, in addition to the office staff, consists of 66 County Medical Inspectors, 105 Deputy Medical Inspectors (Railway Examiners), 670 Health Officers, and will include in a short time upward of 1,000 Medical Inspectors for schools.

THE DIVISION OF SANITARY ENGINEERING is one of great importance in the Department's work and is organized with seven sub-divisions, each with a staff of from eight to eighty persons, and all under the supervision of a Chief Sanitary Engineer.

The Act creating the Department places under the Commissioner's supervision all public water supplies and all public and private systems for sewage disposal. Details of every sewage disposal plant in the Commonwealth must be filed with the Department of Health and new construction can only be begun after the Commissioner, the Governor and the Attorney General have approved of the plan. After full investigations have been made by the Sanitary Engineering Division and the consent of the Governor and Auditing General has been secured, decrees are issued by the Commissioner permitting the installation of sewage disposal works or the extension of systems already constructed.

The Water Supply Commission arranges an equitable distribution of the public waters of the state and grants permission for its use. The details of all such water works must be submitted to the Commissioner of Health and his approval must be secured before construction can take place. This Division supervises the abatement of pollutions and the removal of nuisances.

One sub-division of the Sanitary Engineering Division is devoted to office work; a second, to that of map making; a third, to petty nusiances and complaints; a fourth, to sanitary field inspection; a fifth, to water works and sewage construction; a sixth, to the study of the purity of water supplies; a seventh, to effluents from disposal plants.

The total number of professional men and especially trained inspectors in this division reaches 106.

TUBERCULOSIS. In 1907 $1,000,000 was granted the Department for the purpose of organizing a campaign against tuberculosis. Two important divisions were organized for this work; a Sanatorium Division and one of Tuberculosis Dispensaries.

THE SANATORIUM DIVISION was permitted to take over a small camp already organized in the State Forestry Department at Mont Alto, in the southern part of the Commonwealth. This plant was immediately enlarged to several times its capacity and comprehensive plans were drawn for building a great sanatorium for incipient cases with provision for infirmary care for advanced cases.

THE DISPENSARY DIVISION at first consisted of a Chief of Dispensaries and a local representative—the County Medical Inspector—in 67 counties, each in charge of a dispensary. Later these dispensaries were increased to 115 in number and assistants were appointed in all the larger cities. Nurses were soon found to be an essential adjunct to this work so that today including 120 Dispensary Chiefs, we have a total of 280 medical men connected with this division and 160 nurses. Two medical men assist the Chief of Dispensaries in a supervising capacity and two nurses are devoting their entire time to supervising the nursing end of the campaign. Each large center of population in the Commonwealth is now provided with a Tuberculosis Dispensary where the indigent may secure free treatment, free advice, and the usual supplies required to prevent dissemination of the disease, and in case of great need, eggs and milk. This division at the present time includes a total of 348.

Later appropriations for Tuberculosis—$2,000,000 in 1909—enabled the Department to increase the size of Mont Alto Sanatorium. Today it accommodates nearly 800 patients and will, when buildings now under construction are completed, accommodate more than 1,000 patients. Contracts have been awarded for building one additional sanatorium with large provision for advanced cases in the Allegheny mountains west of the centre of the state on the beautiful tract of land presented to the Commonwealth by Mr. Andrew Carnegie. Land has been purchased near Hamburg, southeast of the centre of the Commonwealth, and a third sanatorium will be erected at this point as soon as additional funds are appropriated.

LABORATORIES. A well equipped laboratory is an essential part of every public health organization, Through the liberality of the University of Pennsylvania, opportunity was afforded to organize a Laboratory Division that should place at the disposal of the physicians of the Common-

wealth skilled scientists whose services could be given to diagnostic work, and liberal provision was made for conducting research work. In this laboratory the Department not only undertakes to study blood, urine, sputum and cultures and complete chemical and bacteriological analyses of water supplies and effluents from sewage disposal works, but pathological tissues are carefully studied from the standpoint of morbid pathology as well as from the standpoint of the pathologic histologist, the diagnosis in each instance being forwarded to the family doctor.

Research work undertaken by this division is far reaching and permits officers to go into the field in times of epidemic for the purpose of studying unusual outbreaks of disease. It has permitted the development of a system of preparing tubercle bacilli products, after a plan worked out by the Commissioner,. that are now being successfully used in our dispensaries and sanatorium.

Division of Distribution of Biological Products. Another important division of the Department's work is that of the distribution of biological products. Through this division, diphtheria antitoxin is supplied free of cost to the poor from 650 distributing stations, each located at a convenient point in large centres of population. Tetanus antitoxin is supplied through 67 distributors, one in each county. Vaccine virus is distributed for the use of the Department's field officers and for the poor in second-class townships and in charitable institutions unable to pay for it. Tubercle bacilli products, one an extract in seventeen dilutions and the other a suspension of dead bacilli in sixteen different dilutions are distributed to the 120 dispensaries and to the sanatorium.

The Accounting, Auditing and Purchasing Division audits all accounts and purchases all supplies except for office work, the latter being purchased by the Department of Public Grounds and Buildings.

The Division of Supplies carries in stock everything required for the work of the various field officers and the working staff of the State Capitol and distributes material on receipt of requisitions properly countersigned. The Division is practically a Department Store and shipping agency.

Educational Publicity. It will be seen by this brief description of a plan of organization that the Chiefs of each of the various divisions receive their reports from the sub-heads and field officers, that they in turn utilize these reports and compile them for forwarding to the Commissioner. In the office of the Commissioner these reports are all re-edited for purposes of public instruction. Everything of educational value gathered in the most remote corners of the Commonwealth is diverted through the Division Chief to the Commissioner and is by him reflected back to the public

through an important sub-division of his office staff devoting its time to editing department reports and promoting their publication. Indeed, this is one of the most valuable features of a public health campaign in any Commonwealth. Many avenues are open for such an educational campaign.

In addition to editing annual reports and summarizing all of the work done during the year, monthly bulletins are published and distributed to the physicians and health workers throughout the Commonwealth and adjoining Commonwealths, and weekly talks are given through the daily papers, educational stories being sent to all the great dailies; to some 900 small weekly newspapers throughout the country districts; a travelling tuberculosis and sanitary exhibit is maintained, giving public lectures in all large centres of population; papers are read before scientific societies, charitable organizations, Boards of Trade, Civic Clubs, Teachers' Institutes and various bodies interested in the welfare of the public; circulars of instructions are edited giving details of household isolation, quarantine and care of the sick, and the laity are constantly kept informed of all the work undertaken by the State Department of Health. In other words, these reports are rewritten and popularized by this important sub-division of the Commissioner's office staff.

You will have gathered from this meagre description that Pennsylvania's State Department of Health is a large organization and has many employes, a total of more than three thousand, shortly to be increased with the medical inspection of schools to 4,000 individuals. As public health workers you will be interested to know something of the method of remunerating those who do the work. Every one connected with the office work of the department, from the Commissioner down to the most humble employee, receives either a yearly or monthly salary. The local registrars are paid fees for forwarding death and birth certificates by the respective counties. The County Medical Inspectors receive $1.25 per hour and all expenses when at work. Health Officers are paid 40 cents per hour and expenses.

Tuberculosis Dispensary Chiefs receive $2.00 per hour, their assistants $1.25 and $1.00 per hour. Nurses in dispensaries are paid a monthly salary, those in the larger cities receiving more than those who work in country districts, and all are allowed their travelling expenses. The Sanatorium staff are paid stipulated salaries.

The subject of this paper is The Organization of a State Department of Health. As Pennsylvania has been used as an example, may we not hurriedly glance at some of the results which this organization has accomplished.

From June 1, 1907 to June 30, 1910, 3,301 patients had been admitted to our State Sanatorium for Tuberculosis at Mont Alto. Many patients have been discharged with the disease arrested, hundreds have been benefited, and many more whose cases were too far advanced to hope for much aid have, however, been made comfortable and happy and have been provided with a home where they would not be a source of danger to others.

From July 22, 1907, to June 30, 1910, 32,247 poor tuberculous sufferers had received the skilled medical aid and the attention of trained nurses which the Department's one hundred and fifteen dispensaries provide.

The death rate from tuberculosis in Pennsylvania had fallen from 134 to 120 per one hundred thousand of polulation in four years. This means a saving of 1,000 lives annually.

From October, 1905, when the state began its free distribution of diphtheria antitoxin among the poor, down to Dec. 31, 1909, 20,794 cases of this dread disease, mostly little children, were treated with the life saving serum. We know by statistics that without antitoxin 42 out of every 100 of these children would probably have died but with the aid of the State's antitoxin the death rate among these poor little sufferers was reduced to 8.48. Free antitoxin was also given in 15,125 cases, mostly children who had been in contact with the disease. All but a very few of these were absolutely protected against diphtheria. A very low estimate of the saving of child life resulting from the state's free distribution of diphtheria antitoxin since 1905 is about 8,000 lives—a pretty good investment of the taxpayer's money.

Throughout Pennsylvania our streams are slowly but surely being freed from pollution. Not so slowly either, when the records show that up to June 30, 1910, 21,730 private sources of stream pollution have been abated upon notice from the Department, not to speak of the thousands more that have been stopped through the moral influence of this work. Seventy-six modern sewage disposal plants have been either built or are in the progress of construction as approved by the state. Two hundred and thirty-six other municipalities and private sewage corporations are preparing to submit plans for sewage treatment, for only on condition of their so doing have they been permitted to extend their sewerage systems. Already 47 modern water filtration plants have been approved by the state and are either built or being erected.

And what of typhoid fever in view of all this work for pure water? In 1906, 56.5 out of every 100,000 people died from this disease; in 1907, 50.3; in 1908, 34.4; and in 1909, 23.9. That is, there are now living 2,363 people who, had the death rate of 1906 prevailed in 1909, would have died from typhoid.

In 1906 and 1907, the death rate in PennsÁlvania per 1,000 of population was 16.5; in 1908, it had dropped to 15.7 and in 1909 to 15.3. At first glance this may not seem a remarkable diminution, but in a state with a population of more than 7,000,000 even a fractional decrease is a substantial gain. This appears when one figures precisely what this slight numerical drop means in the actual saving of human lives. Had the death rate of 1906 and 1907 prevailed in 1908, 5,519 more people would have died than actually succumbed. Had this same rate applied in 1909, instead of the decreased percentage recorded by the Department of Health, just 8,388 men, women and children now living and presumably in good health and spirits, would have died. In other words, these matter of fact statistics, when interpreted in their real relation to the welfare and happiness of the state, mean the saving to Pennsylvania of 13,907 lives in two years.

And we are going to fight on!

EXECUTIVE METHODS IN PREVENTIVE MEDICINE.*

HENRY BIXBY HEMENWAY, A. M., M. D.
Evanston, Illinois.

A few years ago there were practically no trained executives for public health work. There were few general rules for guidance. Because there was a chance for so much difference of opinion as to administration, and each case must be considered by itself, it seemed necessary to have boards of health. Because the questions were essentially local, and the dependence of one community upon another were not so clearly perceived as it is today, the work was conducted by local agencies and the state efforts were loosely supervisory and advisory.

Today all is changed. Modern commercial methods and advance of sanitary science have demonstrated that the residents of a city like Chicago or New York are almost as vitally interested in the administration of the health departments of the rural communities a hundred miles away, as they are within the city walls. Especially in the United States the science of preventive medicine has advanced far beyond its administration. We have consequently reached a turning point. General rules must be formulated and the methods should be radically changed. Efficiency in the future will depend in no small degree upon a clear perception of the legal duties and limitations of state health executives.

The membership in this Association includes representatives from governments widely differing in character. Methods which might be legal in Canada are not so in the United States, and systems which are advisable in Mexico, might be inefficient in other lands. "The real character of a governmental system is determined by the laws in accordance with which it is supposed to act, but also by extra-legal conditions and practices."[1] These practices which are nearly as binding as the written law must be recognized, though they may not appear in the study of the law alone. They originate from the history and education of the people.

Individual liberty is safeguarded by the separation of the three branches of government: legislative, executive and judicial. This separation is not as complete in England and her colonies as it is in the United States, where it is required by the national and state constitutions. That of Illinois, for example, provides that "no person, or collection of persons,

1. Goodnow, Principles of Administrative Law in U. S., p. 4.

* Read at 38th Annual Meeting of American Public Health Association, Milwaukee, September, 1910.

being one of these departments, shall exercise any power properly, belonging to either of the others, except as hereinafter expressly directed or permitted."[2] The exceptions are such as the veto power and impeachment trials. The Constitution of Mexico says:[3] "The supreme power of the Federation is divided for its exercise into legislative, executive and judicial. Two or more of these powers shall never be united in one person or corporation, nor the legislative power be deposited in one individual." Similar provisions are found in the Constitutions of other Latin-American nations.

By the Canadian Constitution, the British North America Act of 1867,[4] the initiative for certain kinds of legislation is reserved to the Governor General. In Belgium,[5] the King holds a third of the legislative power, and has the right of initiative upon legislative matters. And "the interpretation of laws by authority belongs only to the legislative power;"[6] but such interpretation is not really interpretation, but new legislation. It gives an uncurbed power for oppression, which would not be permitted in Anglican communities. So, too, if the executive and judicial powers are united, either in one person or in a body of men, tyranny becomes easy. Every citizen has rights and one of these is that he shall know that the strong arm of the law will protect and not oppress him.

In the United States therefore the law is above the government. "No man is so high as to be above the law. No officer of the Government may disregard it with impunity."[7] No officer, therefore, who belongs to an executive office has any legislative or judicial power; and if he seeks to exert such power he becomes legally liable for any damages which may result to any citizen. For a health executive to require scholars to be vaccinated before entering school is an unwarranted usurpation of legislative power, in the absence of epidemic, or a state statute so ordering.[8] To decide which diseases should be quarantined is essentially a judicial or legislative procedure which the courts will not permit to the executive.[9] It is undisputed in the American decisions that a Board of Health, or a health executive, have no legislative power whatever.

It is true that health departments may make rules and regulations, and it is often claimed by such departments that these rules and regulations have the force of law. That is a very unfortunate misconception. "It is a principle not questioned, that except where authorized by the Constitution, as in respect to municipalities, the legislature cannot delegate legislative powers—cannot confer on any body or person the power to

2. Art. III.
3. Article 50.
4. Sections 53 and 54.
5. Articles 26 and 27.
6. Article 28.
7. Miller, Constitution, p. 33.
8. Potts, v. Breen, 167 Ill. 67; State v. Burge, 70 N. W. R. 347; Jenkins v. Board of Education, 234 Ill. 422.
9. Kirk v. Wyman, 65 S. E. R. 387.

determine what shall be law. The legislature only must do this.[10]" There are numerous decisions to this effect.

"A regulation which is in effect legislation is in a just sense a regulation no longer. That is, as a regulation is a derivative, it must keep within the scope of the statute under which it is framed."[11] "What is allowed to to be done is anything within the law that is in execution of it; what is forbidden to be done is anything without the law that is in extension of it. In execution anything may be done that is administration, nothing may de bone that is legislation—is the principal distinction."[12] Thus, a statute provided for the free entry of animals for breeding purposes. The Secretary of the Treasury ruled that the collector must be satisfied that the animals were of superior quality. Court held this was legislation, not regulation.[13] So, too, when the Postmaster General ruled that second class matter should only include such publications as consisted of the current news, or miscellaneous literature, and excluded a collection of railroad timetables, the Court held the regulation to be legislation, and therefore void.[14] As to the power of the State Board of Health to order vaccination the Supreme Court of Illinois said:[15] "It had and could have no legislative power. Its duties were purely ministerial, and the provision of the statute authorizing the board to make such rules and regulations as it should from time to time deem necessary for the preservation or improvement of the public health cannot be held to confer that broad discretionary power contended for."

It is frequently necessary for every executive officer of government to interpret the laws for his own guidance. Only a court can give an authoritative interpretation. It is the duty of the executive to apply the law only. "All that is allowed to the administration is action within the scope of its authority."[16]

All public health authority is included in that which is commonly called police power. Unfortunately the habit of referring to certain public officers of the peace as policemen has caused sometimes a little confusion as to the meaning of the expression police power. Originally the term police referred to all the functions of municipal government. Later it was used to indicate all internal administration. Today it has come to mean that part of the administration of internal affairs which attempts to prevent the happening of evil and to suppress violations of the law.[17] Jeremy Benthem defined it as "a system of precaution, either for the prevention of crimes or calamities.[18]" It includes legislative acts, and is

10. State v. Young, 29 Minn. 551.
11. Wyman, Administrative Law, Sec. 133.
12. Wyman, Ad. Law, Sec. 99.
13. Morrill v. Jones, 106. U. S. 466.
14. Pub. Co. v. Payne, 30 Was. L. R. 339.
15. Potts v. Breen, 167 Ill. 67.
16. Wyman, Ad. Law, 130.
17. Goodnow, Municipal Government, p. 234.
18. Works, Ed. Ed., Part IX, p. 157.

by no means limited to the power of an executive to act under general statutes. "This extraordinary and dangerous power is not of constitutional origin or grant. It is institutional and inherent in government; and, as wisely remarked by Chief Justice Shaw, 'it is much easier to perceive and realize the existence and source of this power than to mark its boundaries or prescribe limits to its exercise.' * * * * Its summary exercise is always perilous to private right, and often cruelly unjust."[19] "The range of the internal police is wider than police power."[20]

The license of milk dealers,[21] the regulation of the practice of medicine,[22] and providing pure water for the citizens,[23] are illustrations of the use of police power. "This power is inherent in the state, and may be delegated to public corporations. It is usually exercised by state officials, or delegated to municipalities.[24]" Because of the dangerous nature of this power the courts are inclined to scrutinize very closely the methods of its application. The tendency is to leave less to the discretion of the administrator, and insist upon legislation by the proper body.

"In the United States, also, the police of public health and safety starts from the idea of nuisance. It is further based upon the principal that there is to be a legislative determination in great detail as to what are nuisances. There is not in this country any elaborate statute on the subject, and in those states where special legislation is permitted by the constitution much of the legislation is contained in statutes which affect only one city."[25] In this regard we are far behind England.

The quotation given above from Professor Goodnow is a just criticism upon our sanitary legislation. The restriction of infectious diseases in a dairy district or the lack of such regulation may have a great influence upon a municipality far distant. The city is unable to protect itself, for the reason that its officers have no authority outside its limits. It is difficult and expensive for it to keep inspectors or detectives traveling far from home.

Though much of the administration of health departments is in the hands of locally appointed or elected officers, it is really state work, even more so than that of police departments. Dillon says:[26] "It is important to bear in mind the before mentioned distinction between state officers—that is, officers whose duties concern the state at large, or the general public, although exercised within defined territorial limits—and municipal officers, whose functions relate exclusively to local concerns of the particu-

19. Ingersoll, Public Corp. 115.
20. Freund, Police Power, Sec. 23.
21. State V. Dupaquier, 46. La. Ann. 577; People v. Vandecarr, 81 App. Div. 128.
22. Watson v. Maryland, 30 S. C. R. 644; Dent v. State, 129 U. S. 114.
23. Kennedy v. Phelps, 10 La. Ann. 227; Suffield v. Hathaway, 44 Conn. 521; Smith v. Nashville 88 Tenn. 464.
24. Ingersoll, Pub. Corp. Sec. 19.
25. Goodnow, Munic. Gov. p. 271.
26. Municipal Corporations, Sec. 58.

lar municipality. The administration of justice, the preservation of the public peace and the like, although confined to local agencies, are matters of public concern; while the enforcement of municipal by-laws proper, the establishment of gasworks, the construction of sewers and the like, are matters which pertain to the municipality as distinguished from the state at large."[27] For this reason in a number of states it has been held that police officers may be appointed through state agencies, and when the municipality has immediate control it is acting as the agent of the state.[28] The state may fix the pay of municipal police.[29]

A theft or a murder, in one community, does not greatly endanger others. This is not true of infectious diseases. The negligence in San Francisco has spread the plague germs throughout a wide territory through the agency of the rats and ground squirrels. Our frequent and rapid modes of transportation afford an easy method for conveying disease, as well as persons or freight, from one section to another. Health administration, therefore, is a state affair, though the state may permit its constituent portions to administer the laws enacted. A city health officer is a public officer.[30]

According to the common law a state cannot be sued in tort, and most of the state constitutions specify that the state may not be so sued. So long as a state officer is acting within the law he is protected from action at law, even though he may have made a mistake, and though harm has thus resulted to a citizen. "The immunity of a state from suit is absolute and unqualified, and the constitutional provision securing it is not to be construed so as to place the state within the reach of the process of the court. Accordingly, it is equally well settled that a suit against the officers of a state to compel them to do acts which constitute a performance by one of its contracts, is in effect a suit against the state itself."[31] On the other hand, when an officer of government performs an act not contemplated by the law, he is therein regarded not as an officer, but as a private wrongdoer, and he is held liable for any harm resulting. As Wyman puts it, "If that officer, it may be proved, has deviated ever so little from his legal authority, if, with the best of intention, or with the best of intelligence, he makes a mistake of fact applying the law to a particular case, he is by the principle doctrine, if applied to its logical conclusion, liable as a private wrongdoer, and responsible in such damages as may be proved."[32]

Counties and townships, being only quasi corporations created arbitrarily by the state for convenience in the care of the public business, are

27. Citing, People v. Hurlburt, 24 Mich. 44; Chicago v. Wright, 69 Ill. 326; People v. Draper, 15 N. Y. 543; Wolsey, 95 N. Y. 135; etc. Fairlie, Munic. Adm. p. 142.
28. Fairlie, Munic. Adm. p. 142; Dillon, Mun. Corp. Sec. 40.
29. Baltimore v. State, 15 Md. 376.
30. Throop, Public Officers, Sec. 10; In re Whiting, 2 Barb. 513.
31. Pennoyer v. McConnaughy, 140 U. S. 1.
32. Administrative Law, Sec. 15.

regarded as portions of the state, and equally protected from suits at law, for the torts of their officers.[33] Municipalities, being public corporations, are liable for the acts of their officers when within the law.[34] Health administration has been recognized as in nature governmental, and so protected from action at law,[35] but this will be the more apparent if the local officer is working under a general statute, rather than under a local ordinance. Moreover, since the state is the source of the police power, state statutes have greater force than local ordinances, and they provide a uniform system rather than the confusion which results from relying upon municipal regulation.

Speaking of American administration generally, Mr. Ashley says: "The state executives are ill organized and weak;"[36] and Prof. Goodnow tells us: "The experience of the world is against the administrative arrangements of the states of the American Union."[37] This weakness is strongly shown in the lack of individual responsibility, and technical training, which is a logical result of intrusting the work to political boards.

For over six hundred years the executive powers of Switzerland have been reposed in a council; but that federation is not a nation in the same sense as the United States. At the founding of our nation there were many who feared to trust the executive office of the government to one man, and at first several states voted against that proposition. The Federalist[38] contains a full discussion of the point.

Chief Justice Story has given the subject a somewhat lengthly discussion in his commentary on the Constitution. The argument applies equally well to public health administration. "That unity is conducive to energy will scarcely be disputed. Decision, activity, secrecy, and despatch, will generally characterize the proceedings of one man in a much more eminent degree than the proceedings of a greater number; and in proportion as the number is increased, these qualities will be diminished."[39] "This unity may be destroyed in two ways: first, by vesting the power in two or more magistrates of equal dignity; secondly, by vesting it ostensibly in one man, subject, however, in whole or in part, to the control and advice of a council."[40] Although discussions are beneficial in legislation, after a law is enacted there is no longer occasion for discussion. It is the duty of the executive to administer the law. "No favorable circumstances palliate or atone for the disadvantages of dissention in the executive department. The evils here are pure and unmixed. They embarass and weaken every

33. Barber Co. v. Horn, 48 Ala., 649; Mower v. Leicester, 9 Mass. 247; Elliott, Munic. Corp., Sec. 298.
34. Elliott, Munic. Corp. Sec. 298; Ingersoll, Pub. Corp. Chap. XVI.
35. Levy v. Mayor, 1 Sanford (N. Y.), 465.
36. Local and Central Govt., p. 327.
37. Prin. of Ad. Law, p. 133.
38. Number 70.
39. Sec. 1420. See also 2 Opinions of Attorneys General 482, and 7 Opin., Atty. Gen., 453, 470.
40. Sec. 1421.

plan to which they relate, from the first step to the final conclusion. They constantly counteract the most important ingredients in the executive character—vigor, expedition, and certainty of action."[41] "But the multiplication of voices in the business of the executive renders it difficult to fix the responsibility of either kind; for it is perpetually shifted from one to another. It often becomes impossible, amidst mutual accusations, to determine upon whom the blame ought to rest."[42] The magistrate sinks into comparative insignificance—compelled to follow when he should lead—blamed for acts over which he has no control.

Mr. Justice Miller says:[43] "The nearer we approach to individual responsibility in the executive, the nearer will it come to perfection." Because responsibility is more surely fixed with one executive than with a board, he is more easily restrained from abuse of power, as Delolme has pointed out. There too we have the additional stimulus of personal pride for good work.

A chain is only as strong as its weakest link. Admittedly, today, there are few competent health administrators. The position requires a special education and training such as finds practically no field outside of the public service. The service demands the very best that can be found. It is a practical impossibility to appoint a board of competent sanitarians of equal value. Every member of a board below the best man for this special work, no matter how competent he may be in other lines, is so much dead weight upon the administration. He may be positively antagonistic to good work, on account of his ignorance of the science of public health. He may even help to force the board into some ultra vires tort, for which the competent man who has been overruled, will be held equally liable, legally.

The professional health administrator should be the real head of the department. Whereas, in Prussia and France, the professional administrator is only subject to a general and financial supervision or control, in England "the unprofessional administrators are supreme; they are the authorities, and the salaried experts are merely their agents and servants."[44] This is not an indication of good business sense. It is not productive of efficiency nor economy, yet the United States has adopted the English policy. So we find that the trained sanitarian (if employed at all) is generally subject to, and hampered by, a board of health composed of men who know little of the science of public health, which is as distinct from the practice of medicine, as is that of dentistry.

41. Sec. 1424.
42. Sec. 1425.
43. Constitution, p. 94.
44. Percy Ashley, Local and Central Gov. p. 13.

These boards are generally unpaid. There is no more reason why physicians should give their services in the interest of public health, than there is that lawyers should donate judicial services, or that bankers should freely part with the use of funds for needed public improvement. Such a board may be positively harmful by giving a false sense of protection to the community. Therefore, the general practitioner of medicine who, while not a sanitary expert, accepts appointment upon an unpaid board of health, and does not use every endeavor to secure such a change as shall turn the authority to a salaried expert, is a disgrace to his profession.

The state health department therefore should consist of one man, with his subordinates. Each subordinate should be responsible to his superior for some particular portion of the work, and the chief executive should be held responsible to the people only through the office of the chief executive of the state—the Governor. The work through the state should be uniform. The territory should be divided into districts, after the manner in England. For example, each county should have a commissioner of health, appointed locally, subject to the approval of the state commissioner, and holding office during efficient service. He should be recognized in the law as County Commissioner, and a deputy State Commissioner. Likewise municipal commissioners should be deputy county commissioners. While it is in harmony with American institutions to leave the appointment of local officials to local authorities, and such a system should be fostered, yet such appointments should be to some degree under the supervision of the state executive of health.[45] Appointments should be made with a sole regard to professional efficiency, and should not be dependent upon the previous residence of the candidate within the territory to which he may be appointed. A non-resident is eligible to office unless the contrary is provided by statute.[46]

The right of the state to control local police appointments has already been mentioned. The only way in which an executive may be held responsible for the conduct of his office is by permitting him to appoint his subordinates. An executive has that right.[47] That right seems so important that Mr. Justice Miller devotes much space to the consideration of the infringement upon the constitutional provisions in the present practice of permitting members of Congress to select appointive officers in their respective territories.[48] Still, the power to appoint to office is not an inherent executive function.[49]

45. "The administration of the public health and public charity and the preservation of the peace, cannot be left to localities free of all central control."—Goodnow, Princ. of Ad. Law, p. 58.
46. Com. v. Jones, 12 Pa. 365; State v. George, 23 Fla. 585.
47. Wyman. Ad. Law, 48.
48. Constitution, p. 156, and ff.
49. Elliott, Munic. Corp. 259, citing Fox. v. McDonald, 101 Ala. 46; State v. Boucher, 3. N. Dak. 389; People v. Freeman, 80 Cal. 233; Goodnow, Princ. Ad. Law, p. 98.

Executive duties are ministerial or discretionary. When a specific duty is imposed by the statutes in a mandatory way, the executive power is purely ministerial. If he is permitted to use his judgment, his function is said to be discretionary. "If an officer has discretion he may do any act within that discretion; and all that he does will be held to have been done by express authorization of law. On the other hand, if the duty of the officer is ministerial only, that very act which he had been directed to do can be held to have been done with authorization of law. Therefore, if he acts beyond this express authorization, his acts will be held to be void.[50]

Discretionary power does not imply that the executive may do whatever pleases himself. The action must not be arbitrary, but must be reasonable for the object intended. "The meaning of the term discretionary, when granted by the law, either expressly or by implication, in connection with official duty, is that the discretionary decision shall be the outcome of examination and consideration. In other words, that it shall constitute the discharge of official duty and not be a mere expression of personal will."[51] "It not infrequently happens that the statutes require particular things to be done that must be made to depend upon the judgment—discretion—of a designated officer, and the discretion in such cases is not arbitrary, it is lawful and must be lawfully executed," and an officer is personally liable and amenable for abuse of that discretion.[52] "It follows that boards of health may not deprive any person of his property or his liberty, unless the deprivation is made to appear, by due inquiry, to be reasonably necessary to the public health."[53]

This provision as to reasonableness applies also to legislation, and a law which does not clearly attain the object sought, and with the least oppression, will be declared unconstitutional.[54] An ordinance requiring 3½ per cent. of butter fat in milk is not unreasonable, though it does suppose an unusual degree of care of the cattle.[55] A city may not create a monopoly.[56] The state legislature may pass laws which municipalities would not be permitted to pass.[57] An ordinance cannot be held as unreasonable and void which is expressly authorized by the legislature.[58] So, though creating a monopoly in making a contract for the collection of garbage, the city of Indianapolis was expressly authorized in its charter.[59] Questions of policy determined by the legislature are held conclusive by the court, and not subject to court revision.[60] It is not unreasonable to

50. Wyman, Admin. Law, Sec. 83.
51. U. S. V. Douglas 19 D. C. 99.
52. State v. Yopp, 97, N. C. 478.
53. Kirk v. Wyman, 65 S. E. R. (S. C.) 387.
54. Minnesota v. Barber, 136 U. S. 313; R. R. Co. v. Husen, 5. Otto, 465.
55. Weigand v. Dist. of Col., 22 Appeals D. C. 559.
56. Chicago v. Rumpff, 45 Ill. 90; Landberg v. Chicago, 237 Ill. 117.
57. Jenkins v. Board of Education, 234 Ill. 422.
58. Coal Float Co. v. City of Jefferson, 112 Ind. 15; Cooley, Cons. Lim. 241.
59. Walker v. Jameson, 140 Ind. 591.
60. License Cases, 5 Wall. 462, and 475.

require by law that a druggist shall know the standard of the drugs which he sells[61] or that a dealer should know the standard of the milk which he sells.[62]

Problems of discretionary administration are not always questions of right and wrong, but policy must be used to prevent such opposition as may defeat the end desired.[63] An ordinance in the city of Washington provided for the purchase of milk by an inspector, requiring the dealer to sell "a sample sufficient for the purpose of analysis." An inspector asked for half a pint, but the dealer refused to sell less than a pint, as he sold only full bottles.[64] The court upheld the dealer. On the other hand, an ordinance requiring the dealer to give not exceeding half a pint of milk for analysis was sustained.[65]

The Constitutions of some states[66] provide for special opinions from the supreme courts upon questions submitted by the Governor, Council, or Legislature. Such opinions are not conclusive, as abstract considerations have not the same value as concrete examples. In all cases much depends upon the way a case is presented to a court, and in health administration much depends upon the executive statement of the case.

It is sometimes argued that public health legislation should be in the most general terms, leaving wide discretion to the executive. Professor Freund says:[67] "The maxim of this (police) power is that every individual must submit to such restraints in the exercise of his liberty or of his rights of property as may be required to remove or reduce the danger of the abuse of those rights on the part of those who are unskillful, careless or unscrupulous." By the same principle the community must be protected from the negligence or misdeeds of unskillful, careless or dishonest health executives. There is no portion of the governmental power which possesses greater power for good or ill than the health department. Experience shows that the opportunities afforded have sometimes been used unscrupulously. The greater the latitude of discretion the greater will be the possibility for harm, and the more difficult will it be to curb the injurious effects. It is worth while to consider the opinion of Daniel Webster when he says:[68] "It is an error to suppose that liberty consists in a paucity of laws. If any one wants few laws let him go to Turkey. The Turk enjoys that blessing. That man is free who is protected from injury." Definiteness in legislation increases efficiency. Executive discretion is necessary in health administration, but it should be reduced to a minimum.

61. Dist. of Col., v. Lynham, 16 Appeals D. C. 185.
62. Commonwealth v. Wheeler, 91 N. E. R., 415.
63. See Goodnow, Princ. of Adm. Law, p. 10.
64. Dist. of Col. v. Garrison, 25 Appeals. D. C. 563.
65. State v. Dupaquier, 46. La. Ann. 577.
66. Maine, New Hampshire, Massachusetts and Missouri.
67. Police Power, Sec. 8.
68. Works, Vol II, p. 393.

Exact matters of detail in regard to vital statistics, or laboratory methods, and the conclusions drawn therefrom, may be largely left to subordinates who must of necessity do the work. A knowledge of administration law as applied to public health must be the main staff upon which a good health executive will depend, for his duties require the constant application of those principles, and decisions must be made primarily by him. This does not mean a knowledge of the letter of existing statutes, but rather an appreciation of those broader ideas of government upon which the state is founded. Such a knowledge as will give confidence in execution, celerity of decision, and definiteness of effort must increase the efficiency of all health departments.

In other words, the head of the department should be a professional administrator with a broad knowledge of sanitary science; not merely a sanitarian, nor a party politician.

An army does not consist of generals alone. Neither does the health department of a state consist only, or chiefly, of general officers whose post is at the capitol. Municipal, county and state officials must be recognized as integral parts of one organization. A resident official should be much better able to make a local inspection than a stranger, for he should know the peculiarities of the industrial and social conditions of the populace, and the topography of the ground, better than a stranger. While legally, the state commissioner must be superior to the municipal director, it will often happen that the opinion of the subordinate will be of more value than that of the superior. At least once a year, therefore, there should be a conference of general and county officers. Though such a council would have no legal legislative authority, it might very properly discuss and prepare suitable bills for submission to the legislature. Such bills should be submitted to the Governor in an annual report. Frequent district conferences would help to unify the work, and if they were made public, the educational value for the citizens would aid in effectiveness.

DATA FROM WATER PURIFICA

CITY	Population	Source of Supply	Method of Purification	Average daily Consumption (Million Gallons)	Washwater (per cent.)	Period in Hours
Albany, N. Y.	100,253	Hudson River.	16 rapid sand, 8 slow sand	22.3	...	17.
Cincinnati, O.	364,463	Ohio River	Rapid sand filter using iron and lime as a coagulant.	45.	3.2	48.
Columbus, O.	181,511	Scioto River	Water softening and mechanical filtration.	14.2	0.6	12.
Harrisburg, Pa.	70,000	Susquehanna R.	Mechanical Filtration.	9.1	1.7	6.
Indianapolis, Ind.	233,650	White River	Modified slow sand filtration.	18.7	...	24.
McKeesport, Pa.	42,694	Yoghiogheny R.	Water softening and mechanical filtration.	3.8	0.5	20.
Toledo, O.	170,000	Maumee River	Mechanical filtration.	15.4	2.0	6.
Torresdale, Pa. (Philadelphia)	———	Delaware River	Slow sand filters.	.....	...	.....
Youngstown, O.	80,000	Mahoning River	Mechanical filters.	8.3	4.0	3.
Washington, D.C.	348 460	Potomac River	Sedimentation and low sand filtration.	62.8	0.3	96.

NOTES: The following notes of interest should be added to the data given above.

ALBANY, N. Y.—There are 16 preliminary filters at this Plant, running at an average rate of 86.5 million gallons per acre bacteria per C. C.

CINCINNATI, O.—12 filters were run on an average at this Plant. Each filter has 1400 square feet of Surface, and runs at an

HARRISBURGH, PA.—One of the deaths from Typhoid Fever was that of a tramp.

PHILADELPHIA, PA.—The population of Philadelphia is 1,549,008. The average daily consumption of Water in the city w consumption.

URIFICATION WORKS—December, 1910.

	Washwater (per cent.)	Sedimentation Basins.						Parts per 1,000,000						Nos. of Bacteria per Cu. Centimeter		No. of Deaths from		
		Settling Basin			Coagulation Basin			Unpurified Water			Purified Water							
		Period in Hours	Effluent		Period in Hours	Effluent		Turbidity	Color	Total Hardness	Turbidity	Color	Total Hardness	Unpurified Water	Purified Water	All Causes	Typhoid Fever	Pulmonary Consumption
			Turbidity	Bacteria per c. c.		Turbidity	Bacteria per c. c.											
3	...	17.8	7	71,500	.....	.....	.....	9	34	89	0+	26	89	79,200	180	208	2	23
	3.2	48.0	42	9,100	11	20	3200	110	...	85	0	...	97	32,500	150	547	0	71
2	0.6	12.	1	14	Combined with the sedimentation.			20	25	396	0	6	107	12,000	2	218	1	23
1	1.7	6.0.	...	.....	1.5	.....	21	3	2	...	0	0	...	6,300	3	102	2	7
7	...	24.+	8	700	Combined with the sedimentation.			20	21	316	0+	6	319	1,900	38	340	7	30
8	0.5	20.	0	7	Combined with the sedimentation.			0+	0	157	0	0	70	2,400	5	54	0	5
4	2.0	6.	4	310	Combined with the sedimentation.			74	27	...	0	9	...	10,900	87	171	5	...
...	...	.....	...	.....	.....			28	15	49	0	15	49	12.000	71	...	...	...
3	4.0	3.	20	2,500	Combined with the sedimentation.			48	26	157	0	1	158	32,500	233	...	...	...
8	0.3	96.0	2	900	.....			8	0	111	0	0	117	1,950	39	544	5	68

allons per acre, requiring 2.1% of Wash Water, yielding an effluent which contained, on an average, 1 plus p. p. m. of turbidity, and 26,000

and runs at an average rate of 124 million gallons per acre.

in the city was 208.5 million gallons. There were 2,330 deaths in the city of which 23 were due to Typhoid, and 211 to pulmonary

THE RELATION BETWEEN STATE AND MUNICIPAL BOARDS OF HEALTH.*

By C. A. HARPER, M. D.,
Secretary of the Wisconsin State Board of Health.

The wording of the subject assigned me assumes the existence of a central Board of Health or a Health Commissioner and local municipal organizations.

Since the sins of omission or failure to act on the part of the local Boards of Health usually entirely over-shadows the sins of commission, I look at this topic as one of progression rather than retrogression. Rarely do we find a local Board of Health perniciously active.

Having a local health organization, the question is how can we best promote the cause of public health work? I believe the local Board of Health should be selected by the municipal unit for a period of four terms, and held directly responsible to the people of the community in which the specific health measures are most readily made applicable.

In addition to the local Board of Health organization, there should be a county or district health official, preferably a district, who has general supervision over circumscribed localities, for the purpose of directing the work of the local health official, and making the necessary inspections from time to time as the exigencies of the conditions may necessitate.

Over the county or district health officer should be the State Board of Health or the Health Commissioner, as the custom in the various states may dictate. The Supreme Court of the United States directs that the police power in its broader sense includes every function of civil government, and all measures for the protection of the living and health, the property and the welfare of the inhabitants, and even goes so far as to promote good order and public morals.

Most generally, and certainly most important and far-reaching exercise, is the preservation of the public health.

A state may not divest itself of the police power. It may, however, delegate such power to the various services of government which it creates. This power should be given to local Health Boards and freely exercised by them. At the present time, in the United States, there are various methods of outlining the health organizations. Whatever organization

* Read at 38th Annual Meeting of American Public Health Association, Milwaukee, September, 1910.

may be found in any of the various states, the police power should be specifically understood and the various health authorities made fully acquainted with the meaning of such power.

By such an organization of the health forces within the common welfare, I believe that less friction would be found than would exist under methods that have been proposed from time to time in which the central Board of Health or Health Commissioner might have power to appoint the entire health officer force of the state.

Should such a power exist within the Board of Health, the temptation of diverting the public health measures toward a political organization might be too great at times to be successfully combated. By having the municipal Board of Health unit selected by the municipality itself, the political element or power, as far as the State Board or Health Commissioner might be concerned, would be eliminated.

I maintain, however, that the county or district health officer should be nominated by the central Board of Health. It might be a reasonable measure to have such nomination ratified by the supervisors of the district or county. With this class of health officers, however, the central Board of Health should have the power of removing upon sufficient cause, and thereby hold such officials more directly responsible to the central Board of Health. Such a procedure would eliminate local prejudices, and make the district official feel independent as far as the citizens under his immediate control were concerned.

All power that may be delegated to any board of commissioners should be delegated to the central Board of Health. This board should be advisory in the main, but should be clothed by legislative enactment with such effective authority to determine very freely any reasonable appeal that might be made to it arising from the violation of any public health measure. Such a procedure is only reasonable and just.

The various court organizations of a commonwealth ascend the ladder of authority until the Suprene Court of a state is reached. Such a procedure is also exemplified in the public school system of the various states, a certain unit being established with an intermediate agency or agencies, but usually with one controlling head or institution as far as educational advantages are concerned. Most certainly public health measures should take equal rank in importance, as far as the welfare of the people may be concerned, with the school system or court system of any commonwealth.

The State Board of Health or Health Commissioner should not only have jurisdiction and power of giving advice upon measures pertaining to the welfare of the people, but it should be clothed with the police authority of making investigations at any and all times, and under practically

any and all conditions, in any locality under its jurisdiction in which the application or carrying out of public health measures may be questioned. I believe that the State Board of Health should always have the right to exercise this power whenever in its judgment the conditions would demand such exercise of authority. The question arises as to the expenses that might be incurred in carrying out public health measures, and particularly is this true when the State Board of Health or Health Commissioner may be called upon to act. I believe that two methods of meeting the expense account between the State Board of Health and local Boards of Health should be practiced. When the State Board of Health acts in advisory capacity or investigates upon its own responsibility, the expense of such investigation should be met by the state as a whole. If, however, investigations are made necessary on the part of the State Board of Health in localities where a Health Board is organized, but inefficient, and therefore failing to perform its full duties as far as the interest of the people is concerned, then investigation made by the State Board of Health should be met by the municipality in which such expenses are necessarily incurred. This applies to the Vital Statistics branch also. A provision of this type tends to increase local interest, appeals to the pocket-book of the individual, and therefore is more likely to bring about active measure on the part of the local Board of Health.

My observation has been, however, since we have such powers granted us in the State of Wisconsin, that much greater efficiency can be obtained on the part of the local Board of Health by appealing to the financial side of the situation. Of course we expect that in the course of a few years the vast majority of the people will be so educated that pub-health measures and preventive medicine will be paramount in the public mind, rather than down at the end of the list where it has so long had an unenviable position.

Another provision as far as municipal and central Boards of Health are concerned, is to have some legislative protection thrown around any and all of these organizations against personal financial loss. Unfortunately in the past, when local health authorities are active in the exercising of their duties, and property is destroyed for the benefit of the public, the individuals affected by such destruction of property may have recourse in law for the recovery in damages. Under the present conditions in this state, and I believe similar conditions exist in other states, the state does not stand back of the local health authorities in their acts, but the individuals themselves are liable for damages unless it can be shown in the trial at court that the destruction of property is made absolutely necessary for the protection of the general public.

This tends, in many instances, to make the health officials slow in performing or advancing certain sanitary measures, which, were the officials properly protected by law, could and would readily be advocated.

Matters which concern the state as a whole, such as quarantine, the protection of public water supplies, etc., should be regulated by the central Board of Health, and its rulings should be final as far as the local Boards of Health or district and county health officials are concerned.

The legislature should empower the State Board of Health, or the Health Commissioner, with the power to make rules and regulations concerning certain fundamental forces affecting the health of the people, and when these rules and regulations are made public through the official sources, they should have the effect of law.

It is well to have a general statutory provision which places a penalty clause, with fine or imprisonment, or both fine and imprisonment, upon any rules that the state or local Board of Health may make, providing there is no special penalty clause in the particular provision under consideration. This general penalty clause adds much in putting stamina in the various local Boards of Health.

The central Board of Health or Health Commissioner should make its rules and regulations, which would be applicable to all the citizens under its jurisdiction. These rules should be more or less specific, so that neither the local Board of Health, County Health Officer, nor District Health Officer could violate without rendering themselves liable under penalty. It appears essential from experience that while there is a system of rules adopted by the central health organization, this should not prevent the adoption of further rules by the local health authority in order to meet conditions that may arise in certain specific localities. These rules should not conflict with rules adopted by State Departments.

The relation, therefore, between the State Board of Health or Health Commissioner and the municipal health authorities should be one of co-operation with a centralization of power.

The interchange of ideas, and the knowledge required by each health officer in knowing how other health officers do their work and meet certain emergencies, fully justifies in my mind the labor and expense incident to holding state or district conferences. If the Health Officer expects to impart knowledge to others he must know his subject thoroughly and realize the important roll which sanitation and public hygiene play in the prevention of diseases.

In addition to a general conference I am confident that local conferences should be held, and the State Board of Health and Health Commissioner should be empowered to hold local conferences at such place as the

central body may dictate for the purpose of working out some specific condition.

Since health officers are so poorly paid there should be a provision in the statutes providing that the expense of attendance upon one of these conferences should be met by the municipality sending its representative. Attendance at such conferences should be made compulsory.

I deem it of great importance that some generalized plan be worked out which could be made applicable in the main to the large number of states in the United States. The sooner sanitarians can agree upon certain fundamental bases for exercising and carrying out its effective authority, just that much stronger will the confidence of the people be placed in the beneficent effects of wise public health administration.

Of course, the constitutions of the various states may differ in the granting of powers, and therefore the health organizations must be in accord with the provisions of the constitution.

A multitude of different methods or laws pertaining to any one measure weakens the cause along that particular line materially.

Laboratory Section

THE PRESERVATION OF SEWAGE BY THE AID OF CHLOROFORM AND COLD STORAGE.*

By ARTHUR LEDERER and HARRY B. HOMMON,
Sewage Testing Station of the Sanitary District of Chicago.

In the operation of a Sewage Disposal Plant a very important problem is the collection, storage and preservation of sewage samples for analysis. The question of collection is important because any failure to get a representative sample of the twenty-four hour flow means a failure in the determination of the efficiency of a plant or a particular purification device. It is a well known fact that the composition of sewage will vary hour by hour very considerably even in a dry weather flow.

In a sewage disposal plant which has for its object the purification of one particular sewage and where analyses are made daily, a sample taken once every hour for twenty-four hours, can be conceded as giving a fair average of the daily composition. This refers to the chemical control. The question of bacterial control is much more complicated. In most sewage disposal plants it is a physical impossibility to make enough bacterial examinations in twenty-four hours, especially of the crude and grit chamber sewage, to give absolutely correct figures for one day. This is one of the reasons why we have to rely so much more upon chemical results.

In the outfall of a combined sewerage system of large size, the sewage is either very low in dissolved oxygen (usually in the cold season) or absolutely devoid of dissolved oxygen during the warm months of the year. The chemical changes which a putrescible liquid like sewage is subject to, play an important part where the question of storage and addition of preservatives enter. Ordinary fresh sewage will readily decompose on standing. The "Standard Methods of Water Analysis" consider six hours as a fairly reasonable maximum limit which may last between the collection of a sample and the beginning of its analysis under ordinary conditions. In comparatively few cases will a laboratory be in a position to examine a sample within the first six hours. In our experiments we have studied the

*Read before the Laboratory Section of the American Public Health Association, Milwaukee, September, 1910.

changes which take place in a longer period than six hours. Ordinarily twenty-four hours elapse before the constituents, or part of the constituents, are determined. Very often the changes occurring during storage are overlooked entirely and the samples are allowed to stay at room or ice-box temperatures for a longer period. The change taking place at both temperatures has been investigated and determinations made of the organic nitrogen, free ammonia, nitrates and nitrites at definite intervals. By the determination of these four constituents we obtain the best clue to the changes which occur. During the investigation the room temperature varied, inside of narrow limits, between 25° C. and 28° C., and the cold storage temperature between 10° C. and 12° C. All the experiments have been conducted with RAW, UNFILTERED SEWAGE. The removal of the suspended matter by filtration would give entirely unreliable results which could have no bearing upon the actual conditions under which the analysis of sewage samples is ordinarily carried on. The removal of the suspended matter would simply mean the removal of the greater part of putrescible substances, the behavior of which has to be studied. Fresh sewage only was collected for the experiments.

Simple storage of fresh sewage at room temperature has shown reductions varying between 1.0 to 2.5 p. p. m. of organic nitrogen and increases of 0.8 to 5.0 p. p. m. of free ammonia during the first six hours. The results have been obtained repeatedly. Therefore the analysis of fresh sewage should not be delayed even for six hours if no means of preservation is provided. The change of the nitrogenous constituents in the first twenty-four hours indicates markedly the decomposition which has occurred. The great changes go on during the first forty-eight hours; after forty-eight hours the decrease of organic nitrogen on one hand and increase of free ammonia on the other hand is comparatively slow.

Since the custom has arisen in many sewage disposal plants of keeping composite samples of sewage with a preservative for a week, or even a month or longer before analysis, we endeavored to collate the practice as well as the opinion of laboratory men and sanitary engineers, on the question of preservation of sewage. A circular letter was sent to thirty-four State Board of Health and private laboratories asking for this information. Seventeen gave definite information. When sewage samples could be analyzed the same day, no preservative was used by any of the laboratories. Where preservatives were used, chloroform was given the preference by all but one laboratory. The amount of choloroform used by the different laboratories varies from 5 to 40 c. c. in 4 liters of sewage. On account of the diverse practice we have endeavored to ascertain to what extent chloroform does preserve sewage, and if so, how long, as well as the quantity necessary to absolutely assure preservation.

The quantities of chloroform used in this investigation vary from 1 c. c. to 40 c. c. in 4 liters of sewage. Unfiltered sewages exclusively have been used in this investigation. An investigation by Gage and Adams, published in the Supplement Number II, February, 1906, of the Journal of Infectious Diseases, deals with the question of the preservation of filtered sewages and effluents by the aid of chloroform. The question of the precipitation of collodial matter and consequent influence upon the ratio of soluble and insoluble solids has not been considered by us in this paper. At the sewage testing station of the Sanitary District, the schedule calls for the collection of hourly portions to make a twenty-four composite sample of crude sewage, ten c. c. of chloroform being added to 4 liters, the samples being kept on ice during the collection and analyzed within six hours after the last portion is taken. We have not noticed a single sample among some five thousand samples of crude sewages and sewage effluents in which the chloroform has caused a precipitation of collodial matter. In the effluent of a sprinkling filter especially would such a precipitation be immediately apparent. The addition of 40 c. c. of chloroform to 4 liters may produce a cloudy sample. However, this matter of precipitation depends upon the character of the sewage or effluent and the amount of chloroform added.

The addition of 5 c. c. of chloroform to 4 liters of sewage seemed sufficient to arrest further changes in the nitrites and nitrates; therefore, the determination of these constituents was dropped. Chloroform in the amount of 5 c. c. to 4 liters does not suffice, however, at room temperature. The twenty-four hour changes are distinct.

In order to ascertain the effect of 5 c. c. of chloroform on 4 liters of sewage as compared to straight storage at room temperature, a large sample of sewage was divided into two parts. Thus it could be demonstrated that the inhibitive effect upon the decomposition of the organic nitrogen and upon the free ammonia was fairly decided, but still decomposition went on rigorously. In one case, for instance, the organic nitrogen in the blank sewage decreased 2.24 p. p. m., in the chloroformed sewage only 0.80 p. p. m. during 6 hours, in the same period the free ammonia increased 3.96 p. p. m. in the blank sewage and 2.46 p. p. m. in the chloroformed sewage. Other results have been more or less similar for the 6 hours, 1 day and 2 day periods.

We have also investigated the influence of chloroform (in the proportion of 5 c. c. to 4 liters) upon the bacterial count during 2 weeks' warm storage. Blank determinations have been made for comparison. The samples were plated out on litmus lactose agar and incubated for forty-eight hours at 38° C.

The result is remarkable in that the number of bacteria in the chloroformed sewage increase rapidly while the bacteria in the blank sewage decrease gradually but decidedly. Other determinations, not tabulated, verified this. Only one conclusion is possible, and this is that 5 c. c. of chloroform added to 4 liters of raw, unfiltered sewage, at 22° C. storage, not only does not act as a bacterial poison but rather favors the development of one or more particular groups of bacterial organisms. This is confirmed by the rapid multiplication of the spore formers during the tests.

Another point often overlooked is the correction of the determination of the "oxygen consumed" for the chloroform added. There is a decided difference due to the presence of chloroform. Some investigations were made to find what the correction in the calculation of the "oxygen consumed" should be. The experiments have shown that where only 5 c. c. of chloroform in one gallon of sewage is used an appreciable error is introduced by not correcting for the chloroform. 10 c. c. of chloroform to 4 liters of sewage is a proportion that is used frequently.

When using 10 c. c. of chloroform we noted again that chloroform did not prevent a decided change during the first six hours, but has checked it to some extent. In one case, the organic nitrogen in the blank sewage decreased 2.24 p. p. m., in the chloroformed sewage 0.50 p. p. m. during six hours; in the same period the free ammonia increased 3.96 p. p. m. in the blank sewage and 2.33 p. p. m. in the chloroformed sewage. The differences are still more marked after 24 hours.

Ten c. c. of chloroform to 4 liters of sewage at 22° C. decreases effectively the number of bacterial organisms. Simple warm storage tends likewise to diminish the total number of bacteria within 2 weeks, as has been noted previously in the 5 c. c. chloroform bacterial count.

When using 20 c. c. of chloroform to 4 liters of sewage, we note a check in the decomposition, but action goes on rapidly in spite of the addition of chloroform.

Since the amount of chloroform used to preserve sewage may reach 40 c. c. per liter, investigations were made on this concentration. There seems hardly any necessity for adding more chloroform than is soluble in water, since it is the water soluble part of the chloroform which preserves, if any preserving property exists. The experiments have proven that 40 c. c. of chloroform in warm storage has no more preservative influence on the sewage than 20 c. c. of chloroform. The conclusion to be drawn is that although chloroform does retard decomposition to a slight extent it does not preserve sewage at room temperature, even if added in large quantities.

The analyses made to show the effect of cold storage upon sewage samples demonstrates that cold exercises a remarkable preserving influence upon sewages, and that cold storage apparently is far better than any amount of chloroform added to a sample kept at room temperature, as far as the organic nitrogen and free ammonia is concerned. Out of many analyses made, one may suffice. We found, for instance, in one case, that the organic nitrogen decreased to the extent of 0.86 p. p. m. in 24 hours, and 1.88 p. p. m. in 48 hours; on the other hand, the free ammonia increased 1.90 p. p. m. in 24 hours and did not further increase during the following 24 hours. The nitrites and nitrates tended to decrease quickly as they have done in the warm storage experiments.

In comparing the warm and cold storage experiments, the striking feature is the change in the nitrogenous constituents. During warm storage it is large in comparison with cold storage. There is no doubt that cold storage should be used in preference to warm storage and chloroform when sewages have to be kept previous to analysis. Analyses were made on sewages containing 5 c. c., 10 c. c., 20 c. c., and 40 c., c., of chloroform which have been exposed to cold storage for various lengths of time. Judging by the results obtained, the decrease of the organic nitrogen and the increase of free ammonia in the cold storage samples is influenced by the increasing amounts of chloroform to some extent. If the sewage collected for analysis was fresh and contained some dissolved oxygen, the initial changes in the blank and chloroformed sewage were decided. In such samples it has been found that cold storage alone is a fairly good preservative, much better than warm storage with chloroform. When the sewage is stale, the change in the organic nitrogen and free ammonia is comparatively slow. As far as the nitrites and nitrates are concerned, there is no doubt that the chloroform is effective. In a very large number of experiments not tabulated here, the nitrites disappeared inside of the first few hours at room temperature, as well as cold storage, without chloroform. With the addition of chloroform the nitrites remained stable for at least 24 hours in most cases. The same holds true for the nitrates. While they diminished rapidly in the unchloroformed samples, they remained fairly stable in the chloroformed sewage.

We find again a decided increase of the total bacteria in the 5 c. c. chloroform experiment during a period extending for two weeks, the same as it is shown in warm storage, while the bacteria in the blank sewage decreased. Ten c. c. and 20 c. c. of chloroform proved effective here as before.

We seem justified from these investigations to draw the following conclusions:

1. It is not advisable to store fresh sewages at room temperature pervious to analysis. Even six hours storage will produce perceptible changes in the nitrogenous constituents.

2. The addition of chloroform in amounts of 5 c. c. to 20 c. c. to 4 liters of sewage checks decomposition to some extent. However, even in the presence of chloroform, decomposition takes place so rapidly at room temperature that an immediate analysis becomes necessary when no other methods of effective preservation can be resorted to.

3. Simple cold storage has a pronounced preservative effect upon sewages. It does not inhibit the decomposition completely, but it justifies a short delay before making an analysis.

4. The addition of chloroform to a sewage in cold storage seems to have some influence in checking the decomposition of the organic nitrogen and the free ammonia. However, cold storage without chloroform will have a better effect than warm storage with chloroform upon the organic nitrogen and free ammonia.

5. Inasmuch as chloroform is effective in checking the decomposition of organic nitrogen and free ammonia to some extent and effectively prevents a decrease of nitrates and nitrites, the writers believe that cold storage with the addition of 10 c. c. of chloroform to 4 liters of sewage should be followed in preference to storage at room temperature with the addition of chloroform and in preference to cold storage alone.

6. It is highly desirable that a preservative be found for sewage which should be odorless and colorless. Neither should it change any of the constituents present in the sewage or interfere with any analytical determination. It should be effective at room temperature for a reasonable length of time.

REPORT OF THE COMMITTEE ON STANDARD METHODS FOR THE BACTERIOLOGICAL DIAGNOSIS OF TUBERCULOSIS.*

During the past year your Committee has conducted studies along the lines suggested last year and begs to make the following report:

The diagnosis of tuberculosis by bacteriological methods in the laboratory is applicable in four different ways. First, and most important, the examination of sputum. Second, the examination of urine. Third, the examination of pus and other discharges. Fourth, the examination of tissues.

We believe that public health laboratories should undertake the first three of these examinations as a matter of routine. However, we recognize that tuberculosis is spread chiefly by means of sputum. The examination of the other materials must be determined by the facilities of any given laboratory.

Directions for collecting sputum: We recommend that laboratories supply outfits for collecting sputum, consisting of a wide mouthed bottle of about 30 c. c. capacity, with a cork stopper, and suitably packed for mailing. It is better to put three to five c. c. of a 5% solution of carbolic acid in each bottle. Enclosed with the bottle is a leaflet giving directions for collecting sputum, and blank for the name of the physician sending in the case, the patient's name, date of collection, and other data which circumstances in the laboratory render important. The directions for collecting sputum are as follows:

The first sputum raised in the morning is preferred. If this expectoration is scanty, save the entire amount coughed up in twenty-four hours. Be careful to avoid the contents of the stomach, particles of food, etc. Give only what is coughed up from the lung. Be sure that the cork is tightly inserted into the bottle and that the outside of the bottle is well washed off before packing.

Directions for collecting urine: This should always be done by a physician or a competent nurse. Great care should be taken to wash the meatus thoroughly, and the urine should be drawn with a sterile catheter into a sterile bottle (rubber or glass stopper), with the utmost precautions to avoid contamination, and sent at once to the laboratory. If from a distance it should be packed on ice. In place of ice, antiformin may be added in the proportion of ten per cent. by volume.

* Read before the Laboratory Section of the American Public Health Association, Milwaukee, September, 1910.

Directions for collecting pus: Pus from a freshly opened abscess is to be preferred. If an old sinus exists it should be scraped with a dull curette, and the scrapings be sent with as much pus as possible. Sputum bottles are convenient for the transportation of such material, but the carbolic acid should first be washed out with sterile water.

Fourth. Tissues should be sent wrapped in sterile gauze and packed on ice.

Examination of sputum. For staining, carbol fuchsin is recommended. For decolorization, a mixture consisting of five parts nitric acid and ninety-five parts of 95% alcohol is the most convenient. Those preferring them may use any of the mineral acids up to 10%, but we advise against very strong solutions of acid. Ten bacilli should be found before calling any specimen positive. In the routine examination of sputum, shaking, as recommended by Rickards,* has been found a most useful procedure.

Should the specimen prove negative by the methods so far recommended a substance recently introduced under the trade name, "Antiformin," may be used. Antiformin is composed of equal parts of liquor soda chlorinatae, U. S. P., and a 15% solution of caustic soda. It is used as follows: Mix equal amounts of the sputum and a 15% solution of antiformin. Shake for ten minutes, or until all masses are dissolved, and add normal salt solution up to 15 c. c. Centrifugate for twenty minutes. Decant supernatant fluid and wash sediment by adding distilled water and again centrifugating. This should be repeated three times. (The committee has withdrawn its recommendation for the treatment of sputum with a 2% caustic potash solution on account of the injury done to the staining properties of the tubercle bacillus. Antiformin has a similar action though it is apparently much less marked.)

For routine work the slide or cover slip after being spread should be completely covered with carbol fuchsin and heated gently until vapor shows itself for five minutes before decolorization. If bacilli are not shown by this method, the slide may be immersed for twenty-four hours in cold carbol fuchsin. We find that where the number of bacilli is small this is a much more certain method of revealing them than the rapid stain.

Pus is to be examined in the same manner.

Urine should be centrifugated, the supernatant fluid poured off, distilled water added, and a second centrifugation done. This is best repeated three times and the sediment finally examined as for sputum. Special care must be exercised in fixing the sediment, however. If dried slowly,

* Jour. of Inf. Dis., 1907, Sup. 3, p. 119-122.

the danger of washing off is largely avoided. The addition of a 10% solution of egg white is also useful in fixing the sediment to the slide.

In examinations of all material it may be necessary to resort to animal inoculation. In cases of genito-urinary tuberculosis animal inoculation must always be resorted to before making a positive diagnosis. Antiformin as described above is especially useful in preparing material for inoculation.

In the examination of tissues the method proposed by Mallory and Wright is perhaps the best.

The routine differentiation of the tubercle bacillus from the smegma bacillus is best made by the method of Dahms, but animal inoculation should be resorted to in doubtful cases.

The method of differentiating true bacilli from other members of the acid fast group, devised by Fontes,* is recommended in doubtful cases. We append it with notes of our experience.

(a) Stain preparation by ordinary carbol fuchsin method.

(b) Wash in tap water.

(c) Stain about two minutes with carbol crystal violet (carbol gentian violet gave better results).

(d) Treat with Lugol Solution until no more metallic mirrors are found. (Decolorization is more easily affected if at this point the preparation is blotted thoroughly).

(e) Treat with aceton-alcohol. (Equal parts of aceton and alcohol. Wash until the stain ceases to wash out.)

(f) Wash in distilled water.

(g) Stain with methylene blue.

MAZYCK P. RAVENEL, Chairman.

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*Cent. B. 1. Feb. 26, 1909.

Section of Municipal Health Officers

REPORT OF COMMITTEE ON FOODS.

The task given this committee was that of reporting generally upon foods, and especially upon the question of oversight of milk and water supplies. In gathering information for this report an attempt was made to collect data concerning recent actions of city governments in the matter of adoption of more efficient regulations for controlling food and water supplies. Knowledge as to novel methods of oversight or unusual results from routine inspections was also sought, as were suggestions looking towards improved supervision of food and water supplies.

FOOD STUFFS.

The movement towards more efficient protection of foods, and especially those of the uncooked type, is fortunately becoming widespread.

Boston, a pioneer in this progressive measure, has commenced the prosecution of dealers failing to comply with this regulation, and these actions have resulted favorably to the government.

Washington has a new ordinance aimed at unwholesome food, and this measure also requires more effectual protection of foods in transit through the street, or exposed for sale thereon. More vigorous prosecution of violations of sanitary regulations in this last named city, as applied to the handling and sale of food stuffs, has in five months reduced the ratio of inspections to prosecutions from 1 to 28, to 1 to 45. The Health Department has also begun to prosecute without notice dealers who expose for sale unsound food products; the Washington authorities believe there should be daily inspections of foods offered for sale in retail stores, as in these establishments there is the greatest deterioration of perishable goods.

Seattle also seeks to safeguard food products during transit, and by a recent ordinance all foods, unless properly protected, shall be raised at least two feet above the floor level, and when so raised must be protected from insect life.

Brockton, Mass., seeks to exclude dust and flies from a large variety of vegetables and other food, and such products must be so kept as to be free from contamination from dogs.

* Read before the Section of Municipal Health Officers of the American Public Health Association, Milwaukee, September, 1910.

Salt Lake City requires that foods must be kept 18 inches above the sidewalks, and also provides for the protection of an extensive variety of products, including bread, cake, pastry, candy and confectionery, from dust, dirt and insects, by screens or suitable coverings.

Minneapolis has a new ordinance compelling the licensing of butcher shops, for which there is an obligatory fee. This measure gives the authorities power of rigid oversight of these premises, protects foods from dust and dirt, and prohibits handling by customers, the latter being a novel and praiseworthy measure. The Health Department uses a score card in controlling these establishments.

Seattle has a stringent ordinance regulating bake shops. These establishments are required to provide separate toilets for the different sexes; baths must be furnished, and the employees are required to wear white clothing with sandals and caps. Employees must furnish the Commissioner of Health with a certificate, sworn to by some accredited physician, as to their health, and such certificate must be filed within 24 hours of commencement of service. No person suffering from tuberculosis, syphilis or any venereal disease, or any skin affection, is allowed to work in a bakery. Bake shops must also have direct sunlight and be kept within specified temperature limits.

WATER SUPPLIES.

The control of the water consumed by the inhabitants of any city or town is of vital importance from the health standpoint, and while the past has witnessed the expenditure of vast sums of money in an endeavor to provide ample supplies of pure water and for protection of the same from contamination, the welfare of communities and increase in population will entail the output of further and larger sums to ensure abundant and unpolluted water for the future. Owing to the vastness of this problem and its influence, not only upon the community using a specific supply, but upon those so situated as likely to become contaminating influences, it is believed that the best results can only be attained by state intervention and co-operation with municipal authorities.

New Orleans is spending $28,000,000 for efficient water and sewage systems. The filtration and power plant for this city cost $2,000,000, and has been such a success that bacteriological examination has thus far failed to reveal the presence of pathogenic bacteria.

Montreal is purifying its water by means of calcium hypochlorite and is now considering the installation of a filtration plant.

Ottawa has employed an engineer to investigate its supply and report on the possibilities of its purification. By reason of a recent outbreak of

typhoid fever, Milwaukee was compelled to install a temporary chlorination plant. The providing of a permanent supply of safe water for that city is still under consideration.

Springfield, Mass., has recently installed a new supply, and placed a slow sand filter in operation, by which all of the water now being delivered to the city is being filtered. Chemical and bacteriological tests are made daily. On the fifty miles of water-shed of the new supply, vaults and cesspools are provided for the use of householders, and the city also undertakes the care of all wastes, in order to minimize pollution.

San Francisco provides bi-weekly chemical and bacteriological examinations of water from all sources. The presence of *B. coli*, or an excess of nitrites, is followed by the immediate closing of the supply until the contaminating influences are eliminated.

Seattle, in addition to weekly examinations, maintains a daily patrol system of its water-shed. The work of this patrol is checked graphically by an unique map system, which is sent daily to the Health Department. All trains, when running through this water-shed, are required by law to lock their closets, and the railroads have been compelled to build dikes between the river and their tracks, as well as to construct water-tight bridges, whenever they have crossed any source of water supply.

Baltimore is about to begin the long delayed construction of a filtration plant for the treatment of the water supply of that city.

The character of the water used in Buffalo is ascertained by daily bacteriological tests, and its quality is made known through the public press.

The health authorities of Washington subject the water from wells, both public and private, to chemical and bacteriological examination. Those contaminated are closed, where it is not possible to remove the source of pollution.

Late last year Richmond installed a new system which combines a storage system with four large basins, a change of intake, and the employment of a coagulant. This method has lessened the turbidity and decreased the bacteria, and the treated water has proven satisfactory from every point of view.

Control of water in the form of ice is also attempted by regulation in Chicago, Boston and Brockton, (Mass.) The two last named cities prohibit the sale of ice which by chemical or batceriological tests shows evidence of sewage contamination, or which is visibly polluted by dirt, or ice in or upon which there is any visible foreign matter.

MILK.

While great progress can be noted in the way of improved milk supplies, the principal drawback to pronounced and immediate success in this development is the inertia on the part of the public. Insufficient interest and a desire to procure milk at the lowest price, regardless of quality, are the factors chiefly responsible for this attitude of consumers. Meanwhile, during the period that health officials are teaching the public that unclean, unwholesome milk is a dangerous food product, and that clean milk, like a sealskin garment, is more expensive, and justly so, than its shoddy substitute, we are paying an annual toll in the way of infantile mortality, which will be materially reduced when the public exercises the necessary discrimination and intelligence in the purchase, care and use of milk. Less money spent on millinery and beer and more devoted to procuring clean milk will yield health dividends more than commensurate with the capital thus invested. The presentation and apparently necessary constant reiteration of this text is a task which health officials must assume in order that educational milk campaigns may attain the maximum benefit to consumers.

Investigation denotes much interest on the part of health authorities relative to the inauguration of methods tending to improve milk supplies. New Orleans and Shreveport (La.) have greatly amplified their systems of inspection. The State has just adopted a chemical standard for milk which is proving satisfactory to all parties. The Board of Health of that State has just adopted the score card system for dairies and has commenced making chemical and bacteriological examinations.

The health authorities at Washington believe that bacteriological examinations should be used as a check on the sanitary inspection of places where milk is produced and handled.

Chicago has adopted a regulation requiring sellers of bottled milk to have the names of the person, firm or corporation selling the milk on all bottles or caps used in making such sales. In the enforcement of the bacteriological standard, one action, which resulted favorably to the government, was brought to the attention of the courts.

Boston has inaugurated dairy inspection on a large scale; there have been prosecutions for the sale of milk containing dirt, also where milk was found with an excess of bacteria. After an unparalleled agitation, the regulation requiring the sale of milk in bottles, or other tightly closed or capped containers, went into effect June 15th, and has met with general compliance. Where shopkeepers have refused or neglected to inaugurate this system, licenses have been revoked. From these revocations there

can be an appeal to the State Board of Health, and some of those whose licenses have been revoked have taken advantage of this provision of the law. The adjudication of these appeals is now pending.

Montreal prohibits the sale of milk over 24 hours old, except in the case of milk which, within 8 hours after milking in summer, and 12 hours in winter, has been sterilized, or which has undergone any other treatment approved by the local authorities. This city has also increased its milk inspection staff and a special system has been inaugurated for country service.

Portland, Me., requires all milk to be from tuberculin tested cows.

Salt Lake City, through the operation of its temperature regulation and score card system, has brought about vast improvement in its supply. In that city milk and cream are excluded from all dairies having a rating of less than 50, when scored according to the system of the United States Department of Agriculture.

The health officer of Jacksonville, Fla., after a strenuous educational campaign, succeeded in having an ordinance passed regulating the production, handling, and sale of milk, which carries with it a provision for obligatory enforcement.

At Rochester, N. Y., cards are distributed to the people in the vicinity of milk stations, calling attention to the advantages from the use of clean milk which the city furnishes for infant feeding; parents are also urged to "come and learn how to keep the baby well during hot weather." A plan has recently been placed in operation for the procuring by visiting nurses of medical and social data relating to the families that visit the milk stations; the information so gleaned is recorded on specially devised forms.

Milwaukee reports excellent results from the employment of the score card system; in Minneapolis a regulation requiring the sale of bottled milk in shops is about to be offered.

Buffalo has a specialized milk division with inspection of dairy farms and of all places within the city where milk is handled; samples are procured at the railroad stations and tested daily. Depending upon the bacterial count, of which 500,000 per c. c. is the maximum, milk is interdicted. It is also interdicted for bad or unsanitary surroundings.

The subject of ice cream is also receiving attention. Boston has a regulation requiring its preparation under sanitary surroundings and making it necessary for all employees to wear clean clothing. The number of bacteria is limited by this regulation to 500,000 per c. c. Cleveland is contemplating action relative to this subject. The State of Louisiana has adopted a fat standard of 14 per cent. for this product, and Maryland has just adopted a law limiting the amounts of vegetable gum and gela-

tine to 1 per cent., and requiring a fat content of at least 4 per cent. Notice by labels must be given where ice cream contains artificial flavoring or over 1 per cent. of vegetable gum or gelatine.

Two factors, which may be fairly considered within the scope of the committee, have been brought to our attention during these investigations. One is that of inadequate appropriations and working force for the accomplishment of health work. We believe this contention is justly made and that the condition is almost universal. The maximum results cannot be attained under these circumstances, and the policy of city governments in pursuing a niggardly course in the treatment of health matters cannot be too strongly condemned. Liberal appropriations and intelligent expenditure is both essential and necessary where the health of communities is the chief consideration. Tax payers should insist on the proper share of their contributions being so utilized.

The other and important feature, and one to be recommended, is that of educational work in all health subjects by means of the public press. Keeping the left hand in ignorance of what the right hand is doing is not a good policy in dealing with health subjects. In Salt Lake City this method has been utilized with gratifying results, so that it is now estimated that dairymen, in consequence of the agitation, have been compelled to spend large sums of money upon improvements, and public sentiment has been aroused to such an extent as to compel recognition from even the courts. At Jacksonville, Fla., public opinion in favor of the new milk ordinance was only aroused by means of the daily papers and the influence of the Board of Trade and Women's Club. The health officials of Buffalo consider publicity in all industries depending upon public patronage such as restaurants, bakeries, meat markets and the like, as the most forcible of all auxiliary aids in securing the standard of sanitation. Chicago has utilized the public prints persistently and with good results.

Another aid to publicity is the bulletins issued by health departments. This means is used in many cities and it has proved so efficient in Seattle as to warrant the opinion that much of the backing and support of the health board by the people is attributable to this cause.

JAMES O. JORDAN, Chairman.
T. H. BAKER.
GEORGE W. GOLER.

Section on Vital Statistics

THE NEED OF EXACT ACCOUNTING FOR STILL-BIRTHS.

By JOHN S. FULTON, M. D.,
Baltimore, Md.

There are cogent reasons for desiring uniformity of understanding and practice in the registration of still-births in all parts of the world, but in the Unites States the immediate and pressing reason is that an extraordinary diversity of understanding and practice almost destroys the credibility and comparability of our mortality statistics. Certainly no registrar will contend that very young lives should be excluded from the population account, or that still-births should be included in the mortality account. All are agreed on these two propositions, and yet our mortality statistics would be better understood if all under one year of age were left out of both population and mortality.

A complete account, whether of the living or the dead, is most difficult to obtain, under the age of one year. To the inherent difficulties of accounting for life and death in early infancy, we add in this country the avoidable difficulty of variable definition and treatment of the returned mortality of early infancy. Many registrars give no account whatever of still-births, and where still-births are accounted for, the term "still-birth" is not defined. The mortality of early infancy is everywhere so large that a small discount sensibly affects the total death rate. The exclusion of one from the death list produces, in this country, about the same error as the fictitious addition of fifty to the population.

We do not find that American registrars, in general, are careful to publish the number of the dead who are not counted in the death rates, though it is generally understood that non-residents and the still-born are omitted. The city of St. Paul furnishes an example of frank publication of numbers excluded from the mortality rate on account of tender age. In that city deaths of infants under two weeks of age do not figure in the death rate. The age distribution of the living and of the dead in St. Paul is such that the omission of one from the mortality factor is about equivalent to the

* Read before the Section on Vital Statistics of the American Public Health Association, Milwaukee, September, 1910.

addition of seventy-five to the population. Whenever two hundred deaths of infants under two weeks are omitted from the mortality rate about the same error is produced as if the population were inflated three and four-fifths per cent., enough to create the illusion of one point reduction in the total death rate for all ages. These infants are excluded because they were less than two weeks of age, but if a registrar should desire to omit such infants under the vague title of "still-births," there is no common understanding among registrars to restrain him.

In one European country infants dying well above the age of two weeks are regularly counted as still-births under certain circumstances. The law of that country permits an interval of a month to elapse between the date of birth and the date of registration of the birth. If death occurs in the first month, and it happens that the record of death reaches the registration office ahead of the record of birth the death may be treated as a still-birth.

Irregularities in the statistical treatment of infant deaths are a cause of concern to registrars and health officers in all countries. In 1893, a Committee of the House of Commons on Death Certificates recommended that "Still-births which have reached the stage of development of seven months should be registered upon the certificate of a registered medical practitioner and it should not be permitted to bury or otherwise dispose of the still-birth until an order for burial has been issued by the registrar." Newsholme says that "If a child be born alive, no matter how soon it may die, both birth and death must be registered." Among the rules proposed by the U. S. Census Bureau are the following:

"Rule 5. Children born alive and living for any time whatever, no matter how brief, after birth, should not be classed as still-births, even though reported by the attending physicians or midwives as 'still-born.'

Rule 6. Whenever age in days, hours or minutes is reported for a still-born child, or indicated by a difference between the dates of birth and death, the registrar should secure a statement that will enable the case to be classed with certainty either as a still-birth or as a death. If no additional information can be obtained, the statement of age should govern and the case be compiled as a death and not as a still-birth."

If there is lack of agreement among registrars concerning the definition of a still-birth, among physicians there is no less confusion, and perhaps it is the registrar's task to furnish the needed definition. This vagueness of the medical mind perhaps has prompted the Census Bureau to insert in the standard certificate a supplementary under the seventh item, asking for a statement of age in hours or minutes in case of death on the day of birth.

It would seem easy to define a still-birth, since the preparation of a foetus for extra-uterine life is accomplished in a fairly definite time, and the inception of separate existence is announced by a very manifest physiological act, that of respiration. A babe which has uttered a cry, or performed one act of respiration, has started in the race of human life, and must be counted among the living from the first such act, even though it be counted among the dead after that breath. A delivered foetus, having a pulsating cord or muscular movement, is to be sure not dead, but until it has breathed it is not alive with the aerobic, life. If it fails to breathe, and so dies, it is as truly still-born as it would have been if it had attempted to breathe while in utero and so died by drowning. One of the best definitions of a still-birth says "a still-birth is an infant born during or after the seventh month of utero-gestation and dead without having breathed." The act of respiration is sufficient evidence of fitness to start an independent aerobic existence; better evidence, I suspect, than that on which the period of utero-gestation is sometimes estimated.

We are not likely to be embarrassed by such progress as may be expected in the preservation of infants born before the seventh month. Incubator infants should be counted alive while they live, and figure in the mortality rate when they die. They will never be numerous enough to complicate the mortality statistics.

In these days the necessity of studying the mortality of ante-natal existence is looming up, as the mortality of early infancy is more and more closely examined. For the major part of life we find that our ordinary needs are met by statements of mortality by five year periods. After eighty, we find that such statements are not sufficiently informing, and that expectancy is better expressed in months than in years. But the living are few above eighty, and their future is of small importance. At the beginning of life, however, we find the largest numbers and very important values. We have been a long time familiar with the tall column which begins the mortality curve with the tally of the dead under five years. It has sometimes to be omitted, when one desires to use a vertical scale liberal enough to bring out points in the mortality of adults. This tall column persists when the mortality of the first five years is stated by single years. It falls on the first month in a statement by months, on the first week in a statement by weeks and on the first day in a statement by days. The Census Bureau now publishes statements of mortality by single years under the age of five, and by months in the first year. English and French statisticians give mortality by days for very early infancy, and it would not be surprising if it were found generally advisable to dis-

tribute the mortality of the first two or three weeks by days. The infant mortality of England and Wales in 1907 was stated by single months for the first quarter, and by quarters for the remainder of the first year. From this statement one may derive the ordinates of a mortality curve for the first year by months. The values of these ordinates will be as follows, each figure expressing the mortality per one thousand infants born alive.

40.68, 13.38, 9.91, 8.32, 6.96, 6.28, 5.98, 5.57, 5.28, 5.06, 4.9, 4.78.

The same mortality is stated by weeks for the first three weeks and from this, with the aid of the statement by months, one can plot a curve for the mortality of the first twelve weeks. The ordinates are as follows, each expressing as before the mortality per thousand born alive:

24.39, 7.3, 5.86, 4.8, 4.25, 3.68, 3.35, 3.03, 2.87, 2.68, 2.48, 2.32, 2.2.

Here the figure for the second day has been raised from 5.98, the number given by the Registrar-General.

The mortality of the first day is given and the mortality of the following six days is given in one sum. From these, with the aid of the statement for each of three following weeks, one can obtain the probable ordinates of a curve for the mortality of the first twenty days. These are as follows:

11.34, 3.6, 2.75, 2.33, 1.93, 1.70, 1.47, 1.27, 1.12, 1.02, .93, .90, .87, .85, .84, .84, .82, .82.

Our own census report gives the mortality for the first twelve months separately and they make a fair curve, but the population figures for the same months are grossly defective. The deaths under one month in 1900, in the Registration States were 22,876, and living population at that age is reported to have been only 36,023. At that rate the extinction of the population is in sight. Everywhere the same difficulty is met in enumerating the very young and on this account it has become the practice in other countries to state the infant death rate in relation to the number born alive during the year. That is at present impossible in the United States.

We have seen that short intervals of time must necessarily be studied if we wish to understand the causes of death in the periods of life when the chances of death are strongest, namely at the beginning and end of the recognized span. Noting this tendency of mortality to concentrate on the first five years, on the first of these five, on the first month of the first year, on the first week of the first month, and on the first day of the first week, one is tempted to ask whether the center of effort in the preservation of infant life is located in external life at all, or in antenatal existence. In this connection it is interesting to metion the studies of Karl

Pearson, who was able to distinguish, not seven, but five stages of human life as indicated by the causes of death. Studying the chances of death from old age backward, he found successively three similar curves of probability, consistent with one another and corresponding to age, middle life and youth. The fourth curve was of different type. It terminated in a sharp decline to the point of origin in the third year, and distinguished the mortality of childhood from that of infancy as it was not itself distinguished at the other end from the three other curves. There was left, moreover, a set of figures for deaths of the very young, which failed to continue the story, until theory supplied certain information lacking in statistics, when the theoretical origin of the fifth curve was found to be three quarters of a year before birth. The center of death's aim at infant life, Pearson says, is in the last two months of ante-natal life, and there are, he says, 605 intrauterine deaths for each one thousand living births.

In order to test theory by experience, he secured from the Dublin Rotunda, St. Pancras Maternity, and the Lying-in Charity of Guy's Hospital, statements of their ratios of still-born to living births. For the Rotunda it was 6.9 per cent. from 1847 to 1854, and 6.1 from 1871 to 1875. For St. Pancras it was 3.86 per cent of 13,916 cases. For Guy's it was 3.84 per cent. of 25,777 cases. At first sight these figures compare poorly with the 37 per cent. ante-natal mortality theoretically obtained by Pearson. But the hospital figures account only for the mortality of the last few weeks of gestation, and Pearson's distribution of the 605 antenatal deaths fairly reconciles the apparent discrepancy. He says that 391 deaths occur in the first three months, 131 in the second three months, and 83 in the last three months. In other words, out of 1605 conceptions, 24.4 per cent. die in the first three months, 8.2 per cent. in the second three months, 5.1 per cent. in the last three months, and 62.3 per cent. result in living births. These figures, 391, 131, and 83, indicate a formula for antenatal mortality strikingly like that of early infancy, and confirm the belief that infant mortality needs study in minuter relations to age.

In Pearson's conception of the five special agents of Death, the Special Messenger to infants is stationed, not, as the four others are, beside the pathway of life. He stands on the crown of the arch above the gateway of birth. His weapon is a skull. Bad parentage, Pearson says, is the principal cause of death in early infancy; babes are slain with the bones of their ancestors. If there is not fine accuracy, there is breadth of truth in Pearson's views about the five principal agents of Death, and particularly I think, in his definition of the center of aim of those deadly devices which beset early infancy.

The primary reason, therefore, for uniform and accurate practice in accounting for both living and dead at the threshold of life, is that at that point both living and dead are so numerous that any considerable error vitiates our numerical statements concerning life and death at all ages. The second, and, for the present, less urgent reason is that the master key to the problem of infant mortality is possibly concealed in the bodies and minds of the mothers of children.

Notes and Reviews*

MUNICIPAL SANITATION NOTES.

Dr. C. V. CHAPIN,
Providence, R. I.
(*Reviewer.*)

Profit from Garbage. A great deal has been heard from time to time about the profit to be derived from the utilization of municipal wastes, such as garbage, ashes and other refuse. Most of the statements which appear in the daily press, and even in sanitary journals, are entirely without foundation. Schemes are advertised for the utilization of grease, tankage, paper and junk, and for the production of heat, light and power, and the public is led to believe that the municipality can not only defray a part of the cost of collection, and disposal by such utilization, but can even make a net profit above all expenses. Often times it proves that the cost of utilization is as great, or even greater, than the value of the products saved, so that the total cost of disposal is not even lowered but rather increased. In no case, except the one to be referred to, has the writer ever known of an instance where the value of the products sold yielded a net profit over and above the cost of collection and disposal. In 1910 the city of Worcester obtained a net profit from its garbage, over and above the cost of collection and utilization. The total cost of collection that year was $27,721.29, and the cost of feeding it to swine on the Poor Farm was $11,318.39, thus making the total cost $39,039.68. The value of the pork and swine sold was $43,224.25, leaving a profit of $4,184.57. This phenomenal success was due, of course, to the exceptionally high price of pork in 1910, but for many years the city of Worcester has defrayed the larger part of the cost of collecting its garbage from the profits of its hog farm. The collection of garbage in Worcester is taken care of by the Overseers of the Poor, who feed the garbage to swine upon the Poor Farm. The success of this work is due chiefly to its management by Mr. T. T. Schouler, the Superintendent, whose knowledge of the business has been of so much

EDITOR'S NOTE. Readers are urged to send public health notes of interest to the Editor by whom they will be distributed to the proper reviewer. The sender's name or initials should appear under such notes.

pecuniary advantage to his city. The feeding of garbage to swine is the only way in which its value can be economically utilized, and quite a number of New England cities, either directly or indirectly, receive financial benefit in this way. Of course, not every city is so situated that this method of disposal can be employed. The feeding of garbage to swine usually produces more or less nuisance, and a location in a sparsely settled section must be secured. Undoubtedly the nuisance could be very greatly reduced if sufficient attention were given to it by intelligent persons, and even now there are hog farms that are no more offensive, to say the least, than some crematories and rendering works. It is the writers' belief that more attention should be given to this method of garbage disposal. A careful study of methods would certainly result in a decided diminution of the nuisance which usually accompanies hog raising, and would also materially increase the profits of the business. Small herds of high grade swine are frequently fed on garbage with practically no nuisance and there is no reason why large herds cannot be managed in the same way. One of the greatest improvements which could be made in the collection of garbage would be to have the collections made daily during the summer months. If the money obtained from the sale of pork should be devoted to providing daily collection, it would be a great comfort to the householder, and owing to the fresher conditions of the garbage, would greatly aid the management of the hog business.

Builders' Privies. Notes are frequently found in health reports about the nuisance caused by the temporary privies constructed by contractors. These are usually poorly made and poorly cared for, and are frequently so placed as to be a nuisance to the adjoining property. Sanitary inspectors have a constant struggle to keep these privies in even a passible condition. In Hartford * it is insisted that the privy be removed at the earliest possible moment. Just as soon as the foundation walls are up, connection must be made with the sewer and a temporary water closet installed.

* Report of Board of Health, 1910, p. 46.

PERSONAL HYGIENE NOTES.

PERCY G. STILES,
Assistant Professor of Physiology in Simmons College.
(*Reviewer.*)

Elements in Training. What is the source of the improvement in power and endurance observed when a muscle is regularly exercised? This interesting question has been much discussed but with the general result that the matter appears ever more involved. The number of factors concerned seems constantly to increase as we gain a closer view of neuromuscular physiology. Let us recount some of these factors, beginning with those which have long been recognized and concluding with some very recent suggestions that bear upon the problem.

The fact most familiar to the man in the street is that the active muscle grows. How this actual increase in contractile substance is brought about cannot be regarded as altogether clear. Different writers have emphasized the possible share of various conditions in contributing to the improved nutrition, some laying stress on the increased volume of blood-flow, others on the freer production and movement of lymph, and others upon the effect of fatigue-products. It has been suggested that the accumulation and escape of metabolites from the active cells may give rise to just the conditions which invite the appropriation of food. Actual wear and tear in a tissue seems to stimulate hypertrophy as we see in the formation of callouses in the skin.

While the increasing size of the muscle is an obvious feature of training it is likely to be made too prominent. Betterment of quality is doubtless more important. There is no proportion maintained between the augmented cross-section of the muscle and its efficiency. This is most strikingly true when we turn our attention from the question of absolute power to that of endurance tested through series of moderate contractions. Here we have to do with variations in susceptibility to fatigue and the question becomes a chemical one.

Training affects not simple the conditions within the muscle but also those at the governing centres. The writer has previously pointed out that an untrained muscle may be one in which there are many elements not brought under voluntary control. Perseverance in the use of such a muscle may lead to a reorganization of its centres, making possible a more

complete command of the contractile material. Central training furthermore establishes better co-ordination, eliminates the hindering of one muscle by another, and so secures speed, grace, and economy of effort.

Let us return to the question of the muscle itself. Resistance to fatigue may be variously accounted for. The most novel doctrine is that of Weichardt* who regards fatigue as a specific toxaemia against which the cells in course of time develop a definite antitoxin. The trained muscle is thus regarded as one which enjoys a measure of acquired immunity against a disease, fatigue. It is an immunity purchased at the cost of repeated attacks of the disease. According to this theory, extracts of powerful muscles introduced into the circulation of an untrained subject should render him hardy and enduring. Yet it would be unreasonable to expect too much from such injections, since there is no warrant for expecting that they would give the requisite cardiac and central support. In an article just published, Burridge (of Oxford) adds somewhat to our knowledge of these matters.† He admits the probability that there is a true fatigue toxin but at the same time demonstrates the importance of potassium salts and of lactic acid in lowering irritability. He finds that the end-plates (connecting links between nerve and muscle substance) are the vulnerable part of the system. This characteristic suggests the function of the safety-fuse in electrical devices to the extent that complex structures are shielded from injury by the sacrifice of something readily renewed.

Burridge brings forward the view that the neutralization of lactic acid in muscle is a function of the abundant extractive creatin. Physiologists have always been more or less at a loss to assign any function to this peculiar substance which is carried in the human tissues to an amount of several ounces. Now comes the suggestion that its presence is a measure of endurance. It would be interesting to know whether creatin is much more abundant in birds and animals possessed of great strength than in others. The "gamey" flavor of wild flesh may be assumed to indicate general richness in extractives, but exact analyses would be needed to determine the proportion of creatin. The chemical reaction between creatin and lactic acid is not given by Burridge but it is stated that creatinin is formed.

While endurance may thus depend in part upon the power to neutralize fatigue-substances, we must remember that a good supply of fuel is also essential. A research by Lusk‡ makes this clear. Carbohydrate,

* Münch. med Wchnsch. No. 1, 1904. No. 48, p. 2121, 1904.
† Journal of Physiology, 1910, XLI, p. 285.
‡ American Journal of Physiology, 1911, XXVII, p. 427.

mostly held in the form of glycogen, appears to be the most available source of muscular energy. The glycogen of the body may be rapidly destroyed in contending against cold. Lusk has found that the severe measure of placing a man in an iced bath for some minutes and allowing him to shiver in a cool room afterward will swiftly deplete his hoard of glycogen. The disappearance of this reserve is recognized by a change in the ratio of oxygen consumption to carbon-dioxide production. Now although this principle holds for all subjects, the tabulation shows that it takes much longer to consume the glycogen of an athlete than to expend that of an untrained individual. Hence it is reasonable to infer that a part of the training process is the acquirement of the power to hold glycogen in generous amounts and in readiness to yield its energy on demand. If we combine the views of Burridge and of Lusk we shall conceive the trained muscle to be distinguished both by its high content of creatin and by the exceptional amount of carbohydrate which it holds.

WATER PURIFICATION PLANT NOTES.

W. R. COPELAND, Columbus, Ohio.
(*Reviewer.*)

It is a common impression among the uninformed that when a sample of water is submitted to a chemist for analysis, the latter bases his opinion as to the purity of the water entirely upon the absolute figures obtained. As a prominent chemist once remarked: "A proper interpretation of the results of a sanitary analysis of water is half the analysis.

The analytical data obtained from a sanitary analysis of water may be divided into two groups, biological and chemical. The question of which set of data has the greater amount of significance from the standpoint of Public Health is a perplexing problem to many observers. Take, for example, the following analyses of a surfcae water:

Parts per 1,000,000										Whole Nos. of Bacter. per c. c.	Fermentation Lactose bile	
Ammonia		Nitrite	Nitrate	Oxygen Consumed	Chlorine	Iron	Turbidity	Color	Hardness			
Free	Albuminoid										1 c. c.	1-10 c. c.
0.044	0.094	0.0024	0.9	4.7	3.5	1.5	15	27	168	1,500	Pos.	Neg.
0.022	0.288	0.0106	0.6	7.3	10.0	0.7	49	42	99	25,000	Pos.	Pos.

As the ammonias, nitrites, chlorines, oxygen consumed and bacteria are high, especially in the second sample, the analyst would be justified in condemning the water. The question would arise at once, then, is the water capable of purification? It is. This water can be freed from the turbidity which makes it unsightly, from the salts which make it bad for use in the laundry, and from the bacteria which produce disease—but the chlorine, nitrites, and part of the ammonia will pass through any system of purification (except distillation) practically unchanged. Few people realize this fact. This was illustrated a few months ago by the following incident: A physician, at the head of the chemical department in a medical college in a large city, condemned the public water supply before his classes on the ground that "The city water contains ammonia, chlorine, nitrite and sulphates in pronounced quantities showing that it is polluted." As a matter of fact, the water in question after passing through the city purification works, contained less than 10 bacteria per c. c. on the average, and was being consumed daily by more than 100,000 people with no apparent ill effects. Typhoid fever dropped off 75% in that city as

soon as the purification works started, ten doctors have since left town, and others report a decrease of from $500 to $2,000 in their annual incomes.

Nitrites, sulphates, and chlorides have no sanitary significance in such a water, even in the quantities indicated in the preceding table, for the purification process has removed the dangerous matter which was associated with them in the original source. Therefore the doctor was not justified in condemning the water upon the grounds which he quoted. It should be noted along this line that it is not at all uncommon to have intelligent persons submit a few pints of water, collected in an old whisky bottle or stone jug, to chemists for chemical and even for bacterial analyses, expecting the analyst to be able to tell from the tests whether the water is polluted. Ten chances to one some of the material found in the water would have come from dirt left in bottle before collecting the water.

No chemist or other person is justified in interpreting a water analysis without having full knowledge of the conditions which prevailed at the time of collection. The reason for this is well illustrated by the following example. Two men were sent out on consecutive days to collect water from a river at a certain bridge. One took his sample near the shore, the other went out into the middle of the bridge and filled his bottle from the main channel. Analyses proved that the shore sample contained over 100 parts per million of chlorine, but the channel sample had less than five parts. The reason for this discrepancy lay in the fact that a salt well emptied into the river a short distance above the bridge contaminating the water with chlorine from some deposit of salt deep in the ground. The presence of such a large quantity of chlorine would have justified the chemist in being very suspicious of the water had he not known that there was not a sewer or closet for twenty miles up river.

Waters taken from deep wells are apt to have a number of such special features. Nitrites are common and high nitrates. In regions where coal abounds the iron salts act upon the nitrates reducing them to nitrite. Therefore, while the presence of high nitrite is looked upon as a symptom of sewage pollution in surface waters subject to contamination from privies or house drains, there are many localities where nitrites found in well waters have little significance.

It is, then, of the utmost importance that full information should accompany every sample of water submitted for analysis.

DATA FROM

CITY	Population	Source of Supply	Method of Purification
Albany, N. Y.	100,253	Hudson River	16 rapid sand, 8 slow sand F and Disinfection.
Cincinnati, O.	364,463	Ohio River	Rapid sand filters using iron as a coagulant.
Columbus, O.	181,511	Scioto River	Water softening and me filtration.
Harrisburg, Pa.	70,000	Susquehanna R.	Mechanical Filtration.
McKeesport, Pa.	42,694	Yoghiogheny R.	Water softening and me filtration.
New Orleans, La.	373,000	Mississippi River	Rapid sand filters using iron as a coagulant.
Toledo, O.	170,000	Maumee River	Mechanical filtration.
Washington, D.C.	348,460	Potomac River	Sedimentation and slow san with coagulation.
Youngstown, O.	80,000	Mahoning River	Mechanical Filtration.

NOTE :—The high numbers of bacteria found in the effluent at New Orleans during February w
rapid sand filters.

A FROM WATER PURIFICATION WORKS—February, 1911.

f Purification	Average daily Consumption (Million Gallons)	Washwater (per cent.)	Sedimentation Basins.						Part	
			Settling Basin			Coagulation Basin			Unpurif Wate	
			Period in Hours	Effluent		Period in Hours	Effluent			
				Turbidity	Bacteria per c. c.		Turbidity	Bacteria per c. c.	Turbidity	Color
slow sand Filters m.	21.8	2.9	18.	4	31,400	Combined with the sedimentation.			6	28
s using iron and lime	43.4	2.6	48.	105	5,000	10	16	900	190	...
and mechanical	14.1	1.0	18.	8	9	Combined with the sedimentation.			146	34
ration.	8.0	1.4	6.	...	.....	1.5	.....	36	21	65
and mechanical	3.4	0 3	20.	0	21	Combined with the sedimentation.				0
s using iron and lime	14.2	0.8	4.	425	4,800	24	35	325	450	11
ation.	14.4	1.8	8.	12	514	Combined with the sedimentation.			544	32
nd slow sand filters on.	57.2	3 9	24.	27	9,490	72	15	4,960	111	0
ration.	8.0	4.0	3.	20	3,000	Combined with the sedimentation.			73	24

ing February were caused by Algae Growths. The system of Purification at Cincinnati consists of "Sedimentation without ch

	Parts per 1,000,000						Nos. of Bacteria per Cu. Centimeter		No. of Deaths from		
	Unpurified Water			Purified Water							
	Turbidity	Color	Total Hardness	Turbidity	Color	Total Hardness	Unpurified Water	Purified Water	All Causes	Typhoid Fever	Pulmonary Consumption
n.	6	28	93	0	20	93	37,500	25	196	0	27
	190	...	62	0	...	72	15,000	10	...	1	...
n	146	34	208	0	9	88	8,000	2	207	0	17
	21	65	31	0	0	32	15,000	4	95	...	4
n.		0	120	0	0	81	510	20	75	1	5
	450	11	95	0	4	60	6,000	160	542	3	73
n.	544	32	...	0	7	...	36,400	23	226	2	...
	111	0	54	0	0	54	12,300	83	535	4	61
n.	73	24	54	0	0	56	22,900	96	97	2	6

tion without chemicals, sedmentation with chemicals and

PUBLIC HEALTH, NEWS AND NOTES.

B. L. ARMS, M. D.,
Director of the Board of Health Laboratory, Boston, Mass.*
(*Reviewer.*)

University of Illinois establishes new Chair in Municipal and Sanitary Dairying. The Daily Illini of March 25th contains the following under the head "New Professorship in Dairying is Established":

Burt R. Rickards, of Columbus, Ohio, who has been for two years chief of the laboratories of the Ohio State Board of Health, has just been appointed associate professor of municipal and sanitary dairying in the College of Agriculture.

Professor Rickards is a graduate of the Massachusetts Institute of Technology, 1899. From 1900 to 1908 he was assistant director and director of the Boston Board of Health Laboratory. * * * *

Professor Rickards will enter immediately upon his work at the University of Illinois. His coming will strengthen very greatly the dairy side of the work of the College of Agriculture. * * * *

Health Almanac. The Virginia Health Almanac for 1911 is the title given to the January-February Number of the Virginia Health Bulletin issued by the Board of Health of that state. In the foreword is the statement that the Department does not wish to impress the people once a year with an array of meaningless statistics, but wishes, as far as possible, to inform every citizen every day that much sickness is useless and much disease is preventable. The method is unique.

For each month a disease, especially apt to occur at that time, is singled out and a page of history or common exciting causes is given opposite the calendar for the month and under the calendar a few terse axioms appear. It is surely one which will be kept and referred to frequently.

The March number is devoted to the care of the teeth.

Illinois State Board of Health Bulletins. From Illinois has been received the monthly bulletins and their special bulletins on "The Care of the Baby, Scarlet Fever, Tuberculosis, Typhoid, Smallpox and Diphtheria, all of which are full of trite suggestions, but in the light of our present knowledge of the causation of diphtheria, it seems as if the last-named one should be revised, as it contains the following statement:

*State and City Boards of Health and other organizations are requested to send copies of their reports, bulletins, etc., to the above address for review.

"There is no doubt also, that sewer gas may be a carrier of diphtheritic poison and that many outbreaks hold a close relationship with defective drainage, sewers and cesspools."

There is also a request that the children be warned to rinse the school room drinking cup before using. How much better it would be if there were no school room drinking cups to warn against!

The January Bulletin is especially valuable. Nearly 60 pages are devoted to "The Tuberculin Test—Its Reliability, Efficiency and the Necessity of Its Adoption." Under this head are considered the important work, litigations and conferences on this subject.

Following this we find six pages dealing with pasteurization showing its advantages and objections.

This Bulletin should be read carefully by all who have the oversight of milk supplies.

Prevention of Blindness—Vermont. Among the laws relating to Public Health passed by the Vermont Legislature of 1910 are the following, taken from the Vermont Medical Monthly Volume XVII, No. 3: No. 73—An Act to provide for Medical Inspection of Public and Private Schools; No. 219—An Act to provide for the Registration of Nurses; No. 220—An Act for the Prevention of Blindness:

It is hereby enacted by the General Assembly of the State of Vermont:

SECTION 1. The State Board of Health are hereby empowered to make such rules and regulations as they may deem necessary for the prevention of blindness caused by the disease known as ophthalmia neonatorum, and they may furnish at public expense such prophylactic outfits as are necessary for the use of physicians.

SECTION 2. Any physician who fails to comply with the regulations established under Section 1 of this Act shall be fined ten dollars for each offense and it shall be the duty of the State's attorney to prosecute in all cases on complaint of a local board of health.

SECTION 3. This act shall take effect from its passage. Approved November 11, 1910.

The March number of the monthly bulletin of the Vermont State Board of Health has the following in regard to the above.

DIRECTIONS TO PHYSICIANS REGARDING THEIR PROCEDURE IN CASES OF OPHTHALMIA NEONATORUM.

Ophthalmia neonatorum is an inflammation of the eyes of the newborn baby, which is usually due to infection. If not properly treated, blindness may result. Hence the following routine treatment should be carried out in every case:

Should one or both eyes of an infant become inflamed, swollen and red, and have an unnatural discharge at any time within two weeks after its birth, the nurse, relative or other person having charge of such infant shall report in writing, within six

hours thereafter, to the local health officer of the town or city in which the parents of the infant reside, the fact that such inflammation, swelling and redness exists. Such health officer shall take such immediate action as may be necessary in order that the blindness may be prevented.

Ophthalmia Neonatorum and Infantile Paralysis Reportable in Vermont. There has been added to the list of reportable diseases, the following:

Anterior poliomyelitis, sometimes called infantile paralysis; Ophthalmia neonatorum. Cases of the above-named diseases shall be reported under Section 5454 of the Public Statutes.

Use of the Public Drinking Cup Prohibited in Vermont. At a meeting of the State Board of Health held February 9, the following regulation was adopted:

Whereas, it has been demonstrated that the use of what is known as the common drinking cup is dangerous to the public health and a source of communication of infectious diseases, therefore, under the authority of the statute imposed upon the State Board of Health to promulgate rules and regulations relative to the preservation of the public health in contagious diseases and prevention of the same, the use of the common drinking cup in all public places, parks, fountains, schoolhouses, factories, mills, work shops, libraries, public halls or other public buildings, railroad stations and railroad trains, is hereby prohibited from and after May 1, 1911.

Per order of the State Board of Health, Henry D. Holton, Secretary and Executive Officer, Brattleboro, Vermont, February 28, 1911.

Smallpox Bulletin—Oregon. The Oregon State Board of Health Bulletin October-December, 1910, is devoted to Smallpox and Vaccination, presenting the subject in a very convincing manner.

Distribution of Diphtheria Antitoxin—Texas. The State of Texas now furnishes* Antitoxin at a minimum price to those who can pay, and at the expense of the county or city for the poor.

The Value of Research in Public Health Laboratories. From the excellent report of the bacteriologist of the Province of Alberta, printed in the Annual Report of the Department of Agriculture for 1909 the following is taken.

RESEARCH.

"Just as it is the duty of every physician to endeavor continually to add to his knowledge of medicine and when possible to add to the general fund of medical knowledge, so it is a duty and a necessary function of every laboratory organization to carry on systematic research. Only by so doing can the laboratory maintain its vitality, make progress and realize its highest usefulness. The results of the research work should be published both in the appropriate scientific journals and also in the regular reports of the laboratory. A recognized place for research work in the activities of a

* Bulletin of the Texas State Board of Health, Feb., 1911.

laboratory attracts to its staff men of much higher ability and value than are otherwise obtainable even for adequate salaries. The public thus derives a double benefit from the judicious inclusion of research as one of the functions of the state laboratory.

Finally, a word as to educational work as a function of a public health laboratory. This is not a novel thing for such to undertake as part of its serious and routine business. It is useful and necessary work which can be well and successfully undertaken by the laboratory for several reasons: Its statements are accepted as authoritative; it has the necessary information for a proper campaign of instructing the people; it is in pretty close touch with most of the people who are directly in need of certain definite instruction; and such work can very often be most profitably combined with other duties—for instance, epidemiological investigation."

New Laboratories—Chicago Health Department. In the weekly Bulletin of February 25th, issued by the Department of Health of Chicago we find this statement:

"The Department of Health Laboratories on the seventh floor of the new City Hall, Washington Street Side, are now in working order. In arrangement, appointments and equipment, they no doubt are unequaled—certainly not excelled—by any municipal laboratories in the country. Separate rooms, each splendidly equipped, are provided for the different branches of laboratory work. The chemical laboratories for the chemical examinations of milk, water, food stuffs and general chemical work are in every way up to the latest standard of laboratory construction. The bacteriological division is also perfect in every detail, and with the best facilities for taking care of bacteriological work within the province of a municipal laboratory to do.

For the next two weeks only, the laboratories will be open to the public and those interested in laboratory work and methods will be made welcome."

To the writer it seems a great mistake to announce that the laboratory will be open for inspection for two weeks only as it should be a centre for education, open every day for inspection and instruction.

During the past two months there have been 205 signatures added to the visitors' books at the Boston Board of Health laboratory representing nine states, the District of Columbia, 3 Provinces, Italy and England and of this number 138 were students chiefly from the high schools of Boston. These were shown through the laboratory in small groups and the entire work explained; thus they obtained an idea of the scope of the work and each of them was shown the difference between clean and dirty milk. To further impress the lesson, many of the students were required by their teachers, who in many instances accompanied them, to write a composition telling what they saw.

Our book which has been kept just over two years has signatures from nearly every state, all the eastern provinces and many foreign countries—total number of signatures 1449, and of this number 425 are of the gentler sex.

Ellen H. Richards, Sanitary Chemist.—It is with great regret that we announce that Mrs. Ellen H. Richards passed away at her home in Boston on March 30th.

Mrs. Richards was almost 70 years old and yet in full possession of her faculties, so much so that she attended her classes only a few days before her death, and while still upon a sick bed and supposing herself to be convalescing, put the finishing touches upon an article which she intended to read before the Congress held at the Institute of Technology on April 10th. Mrs. Richards, whose maiden name was Ellen H. Swallow, was a native of Massachusetts and a graduate of Vassar College in the Class of 1870. After leaving Vassar she went to the Massachusetts Institute of Technology, where she graduated in Chemistry with the Degree of Bachelor of Science in 1873.

At the Institute she had the good fortune to come under the personal instruction of William Ripley Nichols, whose services to Sanitary Science, and especially the Science of Water Supply between 1869 and 1886, are well known. A little later Miss Swallow became a graduate student of, and a private assistant to Professor Nichols. Even after her marriage to Professor R. H. Richards of the Institute of Technology she kept up and extended her interest and labors in Sanitary Chemistry. When Professor Nichols was succeeded by Dr. T. M. Drown, Mrs. Richards took charge of the Laboratory of Water Analysis and when the newly reorganized State Board of Health of Massachusetts undertook the problem of the examination of the inland waters of that State, Mrs. Richards, under the general direction of Professor Drown, undertook a large part of the work. This culminated, as many of our readers know well, in the normal chlorine map of Massachusetts, which was the first thing of the kind prepared in any country. This work for the State Board of Health of Massachusetts covered several years and when the 10,000th sample of water came in for analysis a little celebration was held in the Laboratory, greatly to Mrs. Richards' delight. More recently her Laboratory has been perfected and still further improved, her interest in it having remained unabated from that day to this, and a host of students, men and women, having here received their first training in Sanitary Chemistry.

Mrs. Richards was, however, more than a water analyst, more than a Sanitary Chemist. She was a great teacher, and reckoned among her pupils thousands of women all over the country in women's clubs, congresses, schools and colleges who read her books and papers and listened with eagerness to her thoughtful expositions of domestic science and sanitary subjects. She was a leading exponent of the idea that science

ought to be applied to the household, as the titles of various of her books amply testify. Most of these, moreover, have a more or less direct sanitary bearing, as will be readily seen from the titles of some of them, such for example, as her latest, "Conservation by Sanitation," "Home Sanitation" (with Dean Talbot of Chicago University); "Air, Water and Food" (with Professor Woodman of the Institute of Technology); "The Cost of Food"; "The Cost of Shelter"; "Sanitation in Daily Life"; "The Cost of Cleanliness"; "The Cost of Living as Modified by Sanitary Science"; "Industrial Water Analysis"; "Food Materials and Their Adulterations": "The Chemistry of Cooking and Cleaning," etc., etc.

It is doubtful if Mrs. Richards leaves any successor. Her own career, bringing her as it did into close contact with two of the ablest sanitary chemists of the last half century; her extraordinary opportunities in connection with the State Board of Health of Massachusetts; her official position as Instructor in Sanitary Chemistry in the Massachusetts Institute of Technology over a long period of years; together with her natural participation and logical influence in the rise of modern movements in sanitation, applied biology and public health education—all these separately and together contributed to make her a marked and unusual figure.

Those who have had the privilege of being associated with her as fellow students, teachers or workers, can best realize the extent of the loss which public health science has suffered by her death.

WM. T. SEDGWICK.

SANITARY ENGINEERING NOTES.

R. S. WESTON,
Boston, Mass.
(*Reviewer.*)

Water Supply of Marseilles and Trials of Filtering and Sterilizing Apparatus.* The municipal authorities of Marseilles have been conducting experiments on the purification of the domestic water supply of the city. The supply is taken from the river Durance by a canal 58 miles long, completed in 1847. The water is charged with suspended matter, mud and lime.

The methods which have been tried are as follows:

1. Puech-Chabal—Multiple filtration with modifications, using submerged and non-submerged filters and sterilization by ultra-violet rays.
2. Siemens de Frise—Sulphate of Aluminum and Fe_2O_3 and sterilization by ozone.
3. Desrumaux—Sulphate of Aluminum.
4. Otto—Rapid filtration and sterilization by ozone.
5. Duyk.—Chloride of Lime with mechanical filtration.

The first reservoir of the system, about seven miles from the intake, is formed by a gorge with steep sides and an earth-work embankment along which the canal is carried. The reservoir holds 26,400,000 gallons. The water is diverted from the main canal by a weir and is carried by branch canals to a gallery leading to the bottom of the reservoir at a point farthest from the outlet at the end of the dam nearest to the city. The outlet canal is carried back along the whole length of the dam and the flow of water back into the canal is controlled by suitable sluices. Smaller canals are also along the sides of the reservoir for flushing purposes. Cleaning is carried out twice a year. The annual amount of suspended matter amounts to about 156,960 cu. yds. Near Roquefavour are two large decanting reservoirs. A third reservoir at Saint Marthe, a few miles from Marseilles is used as a reserve. The sand filters at Longchamps were abandoned in 1863, too much dependence having been placed in them, inasmuch as the amount of suspended matter is enormous. Even after triple decantion, these filters were called upon to deal with over 90,000 yds. of suspended matter annually. The large reservoir at Realtort, built in 1869, covers 185 acres and holds 937 million gallons.

A reservoir with special reference to flushing was constructed at St. Christophrè. The whole floor of the reservoir has been paved, forming

* W. Clemence, Engineering **91**, 106-8, 139-42.

channels all directing to a central collecting canal. The reservoir is entirely surrounded by a canal by means of which the reservoir is emptied. It can be completely washed out. The cost of the canals and storage reservoirs already exceeds $10,000,000. Tables comparing Marseilles with Hamburg, Bremen and Antwerp, giving the death rate from typhoid, are attached. The latter cities are all supplied from polluted rivers. They all use slow sand filtration, while Marseilles has used the decantation method. During the past ten years 2270 deaths from typhoid have occurred in Marseilles against 386 in Hamburg. It is also interesting to note that Hamburg uses the Elbe, Bremen the Weser, and Antwerp the Nethe river waters, all three streams being extremely polluted and not to be compared in purity with the Durance water.

In 1900 the multiple filtration known as the Puech-Chabal system was tried with a view of comparing it with other methods of treatment. Filters were constructed capable of handling 132,000 gallons in 24 hours, the whole of which passed through three series of gravel filters, followed by a coarse-sand pre-filter. Cascades are introduced in each successive filtration to increase the amount of dissolved oxygen in the water.

A comparison of the bacteriological results obtained by the submerged and non-submerged filters showed decided advantages in favor of the former. Sterilization by means of ultra-violet rays was then tried. The Cooper Hewitt lamp, with quartz tubes instead of glass was used for this purpose. The water was in every case practically sterile. The column of water which flowed under the lamp was 12 inches deep. The lamp drawing 3 amp. at 220 volts was placed horizontally and directly over the water. Experiments showed that the lamp should, if possible, be placed beneath the water, although various difficulties follow the submerging of the lamp. The consumption of current amounts to 26 watt hrs. per cu. m. of water.

Ozone Treatment (Siemens-de Frise System). Used in connection with mechanical filtration. The water is subjected to forced decantation and aluminum sulphate is added previous to decantation. Ozone is supplied by two Siemens-de Frise ozonisers, each group in batteries of eight and enclosed in an iron box with one side of plate glass, forming a water circulating tank. The water has a slight greenish color and on issuing from the apparatus has a decided odor and taste which are said to disappear entirely on storage in a service reservoir. The actual amount of current consumed in the preparation of ozone has not yet been ascertained.

Ozone Treatment (Otto System). Roughing filters made of fine sand are first employed before ozonizing. The ozonizers consist of a series

of glass plates in pairs so that there is a space of about 1 mm. between them. On the outside of the plates, flat metallic chambers are fitted and cooling is effected by circulation of water within these metal chambers. The current is transformed to 12,000 volts for the higher potential.

The sterilization apparatus consists of a tank of ferro-concrete on the top of which the inlet pipes for the clarified water are placed and connected with two injectors in which ozonized air is mixed with the water. Arrangement is made for recovering the excess of ozone. After ozonizing the water is cascaded. The water has an entirely different odor and taste before and after cascading.

MECHANICAL FILTRATION. The mechanical filtration plant tested was of the Desrumaux type, provided with an apparatus for mixing the sulphate of aluminum with the raw water. The sulphate is added in a 3 per cent. solution by a regulating apparatus, using 5 gms. per cu. m. of water. The water is then passed through a decantation tower and is clarified before passing through the filters. The filtering materials used consist of crushed quartz resting on a perforated iron bottom. The filtering layer required cleaning every few hours. The operation is performed by reversing the flow and stirring the bed with mechanically worked rakes.

CHLORINE PROCESS. The Duyk apparatus for sterilization by chloride of lime consists of a decantation tower carrying a tank for mixing the sulphate of aluminum. After the clarified water has passed to the top of the tank the chloride of lime is added by means of an apparatus which delivers 100 c. c. of a 2 per cent. solution of chloride of lime per cu. m. of water.

Tables have been compiled from the various bacteriological reports, giving results of each system. A comparison of these results shows that in multiple filtration without the use of chemicals, the effluent from the rough sand pre-filters has reached a higher bacterial standard than from the high speed mechanical filters, using chemicals as a coagulant. Experiments with the submerged filters and the sprinkler filters show the advantages of the former.

With regard to sterilization, the ozone and the ultra-violet rays are remarkable, reducing the bacteriological count over 99 per cent., completely removing *B. coli*. It remains to be proven yet whether the ozone can be so entirely eliminated as to remove the taste and odor and also whether the corrosive effect of the ozone on the pipes can be completely overcome. It must be remembered, however, that complete sterilization can only be obtained when the water has been previously rendered clear and the number of bacteria largely reduced by efficient filtration.

Clarification must also precede sterilization by chloride of lime, from results achieved. It would seem that there are now reliable methods of

sterilization which may be applied to ordinary filtration works, the output of which may be very largely augmented by increasing the rate of filtration and relying on efficient sterilization apparatus to deal with the bacteria which may have passed the filter owing to the increased speed. In an actual test, speed was increased four times and the effluent was then subjected to the ultra-violet rays. Results at first showed a somewhat high figure for aerobic bacteria after sand filtration, but the number rapidly decreased. Tests after the application of ultra-violet rays showed that *B. coli* was absent.

GEO. B. FRANKFORTER.